A

SURE GUIDE

TO THE

PRACTICAL SURVEYOR,

IN TWO PARTS.

THE FIRST,

Shewing how to Plot all manner of Grounds, whether ſmall Incloſures, Champain-Ground, Wood-Lands, Mountains, and Dales, by the Semicircle, Plain Table, and Chain.

AS ALSO,

How to find the *Area*, or Content thereof, with the manner of Protracting, Reducing, and Dividing the ſame; and alſo how to Incloſe a Mannor lying in a common Field, with the drawing of a perfect Draught or Map thereof, and how to deck and beautifie the ſame.

And likewiſe how to convey Water from any Spring-Head, to any appointed place.

THE SECOND,

Shewing how to take the Ground-Plot of any City or Corporation: As alſo the Menſuration of Roads, High-ways, and Rivers, with the manner of making a *MAP* of any County or Kingdom.

The like never before extant.

By *JOHN HOLWELL*, Philomath.

LONDON,

Printed by *W. Godbid*, for *Chriſtopher Huſſey*, at the *Flower de Luce* in *Little-Britain*, 1678.

SURE GUIDE

UMI

TO THE

RIGHT WORSHIPFUL

JOHN WILDMAN, *Esq;*

SIR,

IF the smallest favours received, merit an acknowledgment from a grateful mind, how shall I demean my self for all those wherewith you have so much obliged me? To excuse my self only by an intention to do something, and to stop and plead my insufficiency as a full excuse, I thought would scarce be allowed by the professors of Gratitude. This Sir, notwithstanding I am convinc'd of my own inability, and that I find every day rather occasions to trouble you, than opportunity to serve you, obliged me to beg of you, to add this favour to those others, which you

have so generously done me, to take this small Piece under your Protection. I have reason to intreat your assistance in its defence, knowing there are so many Criticks who will declare War against it, as is usual against any Man that endeavours to demonstrate a shorter way of knowledge; for truly Sir, this I can safely say, the informing some part of Mankind was my only aim in this undertaking: But I confess, when I resolved to make this piece publick, the Epistle Dedicatory was mainly in the choice of a Patron, to testifie my esteem of those extraordinary Qualifications in you, that have gained you the affections of the best Men, and laid charms of respect upon all that know how to esteem vertue, and also to let the World know, that I am very zealously,

SIR,

Your most humble Servant,

JOHN HOLWELL.

THE

PREFACE

TO THE

READER.

Courteous Reader,

IT may ſeem ſtrange to you that I ſhould put forth a Treatiſe of Surveying, ſeeing there have been Volumes in Folio already written on that ſubject. I Publiſh not this out of prejudice to any Man, or his Works of this nature, but out of love that I bear to the Art it ſelf, and purely to thoſe that are inclinable that way;

For having been ſome years actually concerned in Surveying of Cities, Mannors, Roads, and Rivers, and finding moſt, nay, all Books that are as yet made publick to the World in thoſe very things to be extremely deficient: Therefore I thought ſomething in this nature (not as yet extant) might be very acceptable unto the young Surveyors of this Age; for whoſe ſakes only I have Compoſed this ſmall Treatiſe of *Practical Surveying*. I ſhall not trouble my ſelf to Write any thing in Commendation of the Art, its uſe being ſufficiently known.

As for the Book it ſelf, I ſhall only ſay this: If it proves uſeful, it deſerves thy commendations; if not, I have loſt my deſire.

All that is contained herein, I have endeavoured to make as plain as poſſible

poſſible I can, that thereby the meaneſt apprehenſions may underſtand the ſame. All which I freely commend unto your friendly acceptance; and remain,

Your real Friend.

JOHN HOLWELL.

Arts and Sciences Mathematical, *Profeſſed and Taught by the Author* JOHN HOLWELL, *Philomath. at his Houſe on the Eaſt ſide of* Spittle-Fields, *near the* Red Lyon.

ARithmetick, both Vulgar, Decimal, Logarithmatical, and Inſtrumental; *Geometry*, both Plain and Solid; *Gauging*, *Trigonometry*, *Navigation*, *Surveying*, *Dialling*, in all their Parts; likewiſe *Aſtronomy*, with the Uſe of the *Globes*, both Celeſtial and Terreſtrial: As alſo the Uſe of all *Maps*. Likewiſe he doth Survey *Land* for any Perſon that hath occaſion to imploy him, at a reaſonable Rate.

The Contents of the First Part.

Chap. 1. *Of Instruments in general.*
Chap. 2. *The Description of the* Semicircle.
Chap. 3. *The Description of the* Plain Table.
Chap. 4. *The Description of Mr.* Gunter's *Chain.*
Chap. 5. *The Description of the* Protractor.
Chap. 6. *The Description of the* Field-Book.
Chap. 7. *Containing some Practicals of* Geometry.
Chap. 8. *Of the Use of the Line of Chords.*
Chap. 9. *The Explication of the Table of* Sines *and* Tangents.
Chap. 10. *Of the finding of the* Co-Sine *and* Co-Tangent *of any Angle.*
Chap. 11. *The Explication of the Table of* Logarithms.
Chap. 12. *The Use of the Tables of* Sines, Tangents *and* Logarithms *in the Mensuration of the Sides and Angles of Right-Lin'd Triangles.*
Chap. 13. *Of the placing of the* Semicircle *when an Altitude is to be taken.*
Chap. 14. *Of the taking of accessible Altitudes.*
Chap. 15. *Of the taking of inaccessible Altitudes.*

Chap.

Chap. 16. *Of the taking the Altitude of a Tower ſtanding on a Hill.*

Chap. 17. *Of the taking an inacceſſible Diſtance.*

Chap. 18. *Of the protracting of the Diſtance taken.*

Chap. 19. *Of finding the Horizontal Line of any Hill.*

Chap. 20. *Of the finding the diſtance of many Places from your place of ſtanding.*

Chap. 21. *Of the protracting the Diſtances taken.*

Chap. 22 & 23. *Of the taking and protracting the Plot of any Field at one Station by the* Semicircle.

Chap. 24 & 25. *Of the taking and protracting the Plot of any Field at one Station in any Angle thereof by the* Semicircle.

Chap. 26. *Of the taking the Plot of any Field at one Station in any part thereof by the plain Table.*

Chap. 27 & 28. *Of the taking and protracting the Plot of any Field at two Stations by the* Semicircle.

Chap. 29. *Of the taking the Plot of any Field at two Stations by the plain Table.*

Chap. 30 & 31. *Of the taking the Plot of any Field at one Station in any Angle, and by meaſuring round about the ſame.*

Chap.

Chap. 32. *Of the performing the same by a Sheet of Paper stretched on the plain Table.*

Chap. 33, 34. *Of the taking the Plot of any Field in divers Angles by the* Semicircle.

Chap. 35, 36. *Of the taking and protracting the Plot of any Field at two Stations, and only measuring the Stationary distance.*

Chap. 37. *Of the performing the same by the plain Table.*

Chap. 38, 39. *Of the taking and protracting the Plot of any Field by making Observation at every Angle, and measuring but one Line.*

Chap. 40. *Of the performing the same by the plain Table.*

Chap. 41, 42. *Of the taking and protracting the Plot of any Field by going round the same.*

Chap. 43. *How to know whether you have truly wrought when you make Observation at several Stations in going about the Field.*

Chap. 45, 46. *Of the taking and protracting the Plot of any Field by the Chain only.*

Chap. 47. *Of the finding the* Area *or superficial Content of any Figure, and of the reducing irregular Figures into regular Forms.*

Chap. 48. *Containing several Geometrical Propositions for the separation and division of Land.*

Chap. 49. *Of the casting up the true Content of any piece of Land when you have the sides measured, by Mr.* Gunter's *Chain.*

Chap.

Chap. 50, 51. *Of the taking and protracting of any Manner whatsoever.*
Chap. 52. *Of the reducing a Plot to a greater or lesser Quantity to any proportion.*
Chap. 53. *Of the drawing a perfect Draught of a Manner, and to deck and beautifie the same.*
Chap. 54. *Of the incloſing of any Lordſhip lying in Common Fields.*
Chap. 55. *Of the reducing one kind of Meaſure into another, as Statute-Meaſure into Cuſtomary, and contrary.*
Chap. 56. *Of the Conveying of Water from any Spring-Head to any appointed place.*

The Contents of the Second Part.

Chap. 1. *Of the taking the Ground-plot of any City or Corporation by the* Semicircle.
Chap. 2. *Of the protracting the ſame.*
Chap. 3. *Of the Deſcription of the Wheel by which the Roads are meaſured.*
Chap. 4. *How to take the Plot of any Road.*
Chap. 5. *An Example of the Road meaſured between* London *and* High-Gate.

Chap. 6. *Of the protracting of the Road taken.*
Chap. 7. *How to take the Plot of any River,*
Chap. 8. *An Example of part of* Hackney-River *measured.*
Chap. 9. *Of the taking the Plot of any County.*
Chap. 10. *Of the finding the Horizontal Line of any Hill by the Table of Latitude and Longitude.*
Chap. 11. *Of the finding the Latitude and Longitude of any Place from the place of setting forth.*

ADVERTISEMENT.

FOr as much as the *Practice* of *Surveying* depends much upon the exact making of the Instruments, These are to give notice, that these and all other Instruments for the *Mathematical Practice*, are accurately made and sold by Mr. *Walter Hayes*, at the *Cross-Daggers* in *Moor-fields*, next Door to the *Popes-Head* Tavern, *London*; where they may be furnished with Books to shew the Use of them: As also with all sorts of *Maps*, *Globes*, *Sea-Plats*, *Carpenters* Rules, *Post* and *Pocket Dyals* for any *Latitude*, at reasonable Rates.

A

SURE GUIDE

TO THE

PRACTICAL SURVEYOR.

PART I.

CHAP. I.

Of the moſt Neceſſary Inſtruments appertaining to the Surveying of Land.

ALthough there be in uſe ſeveral Inſtruments among our Modern Surveyors, *viz.* the *Theodolite*, the *Circumferentor*, and the *Plain Table*, and the *Semicircle*; I ſhall only chuſe to make uſe of the *Plain Table* and the *Semicircle*; they being the only Two Inſtruments that are fit for the Practice of Surveying, *viz.* The *Plain Table* for ſmall Encloſures, and the *Semicircle* for large Champain Ground, or for the drawing of the Map of a Mannor, County or City: It may be wondred by ſome, wherefore I do not deſcribe

all the Instruments that I make mention of, and apply them to the Practice of Surveying: To those I answer, By reason the *Theodolite* and the *Circumferentor* do depend wholly upon the Needle, and the Needle I know by experience, doth vary much in some Grounds more than in others; and when the young Surveyor comes to lay down his Work, he will find it a hard matter to make it joyn, and think that he hath taken his Account false, when the fault lay only upon the Needle; therefore to avoid this, I do advise the Surveyor to make use of these Two that I have chosen, and he will find what I have said to be true; therefore I shall describe only these Instruments and the things thereto belonging, and shall apply them to the Practice of Surveying better than any one that hath written before.

CHAP. II.

A Description of the Semicircle *and the Parts thereto belonging.*

THis Instrument consisteth of Four Parts. First, There is a Half Circle of Brass divided into 180 equal parts, called Degrees, the Division beginning at the left hand, and so go round to 180, and then back again to 360. The Second part of this Instrument is the Index that doth move upon the Center of this Half Circle, and upon this Index there are Two Sights with sliding Loops, both of one length, and double sighted, the one having a Slit below, and a Thred

Thred above, and the other a Slit above, and a Thred below, ſerving to look backward and forward at pleaſure without turning about the Inſtrument. The Third part of this Inſtrument is a Box and Needle, the Bottom of this Box having a Card divided into 360 degrees, in which Card alſo there is a Dial drawn, to find the Hour and Azimuth of the Sun; over this Card hangs this Needle, and it is covered with a clear Glaſs to preſerve it from the Wind and Weather. The Fourth Part of this Inſtrument is the Staff that it ſtands upon; it being made to have three Legs, and they to be taken in pieces about the middle, for portable carriage: there doth belong to it alſo a Ball and Socket, and a Plummet to ſet the Inſtrument Horizontal; likewiſe a Scale being divided into equal parts, ſome of them being 10, ſome 12, 16, 18, and 20, to an Inch; and alſo it hath an Inch divided into 100 equal parts together with a Line of Chords; there may be likewiſe a Line of Artificial Sines, Tangents and Numbers placed thereon, to ſupply the wants of the Tables of Sines and Tangents; it being neceſſary for the finding of Diſtances of Places: Their uſe I ſhall ſhew in its proper place. There is a Box or Caſe made to preſerve this Inſtrument from Duſt, Dirt, Bruiſes, and the like.

CHAP. III.

A Deſcription of the Plain Table, *and the Parts thereto belonging, as it is now made.*

THis Inſtrument conſiſteth of ſeveral parts; as firſt, the Table it ſelf being a Parallelogram, containing in length about Fourteen Inches and an half, and in breadth Eleven Inches: This Table is in Three ſeveral Boards, which may be eaſily taken aſunder, for eaſe and convenience of Carriage. The Second part of which this Inſtrument is compoſed, is a Joynted Frame, ſo contrived, that it may be taken off and put on the Table at pleaſure, and that you may faſten a Sheet of Paper upon the Table when you are to deſcribe the Plot of any Field, or other Incloſure by it. This Frame hath near the inward edge on one ſide a Scale of equal parts, for the drawing of parallel Lines upon the Paper with ſpeed and exactneſs; on the other ſide of this Frame (towards the outward edge thereof) there is a Tangent-Line projected, repreſenting the Degrees of a Semicircle, the Center thereof being upon the ſurface of the Table, and numbred from the left to the right hand (when the Center is next to you) by Fives and Tens, to 180, and back again the ſame way to 360, theſe Degrees do ſerve inſtead of the Semicircle; but there do attend many inconveniences

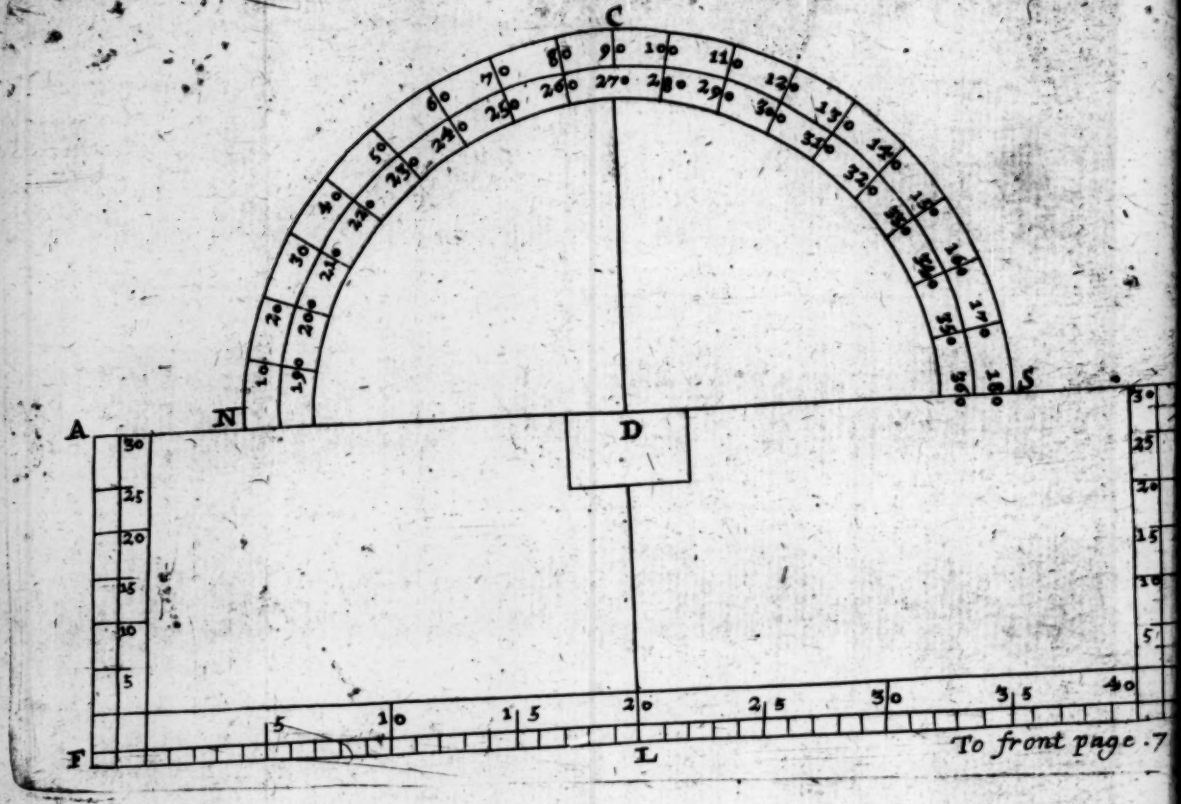
in

in the uſing of them after that manner. The Third part is a Ruler or Index, containing in length about ſixteen inches, it being full as long from Angle to Angle as your Table, and the Breadth about Two Inches, and one third part of an Inch in thickneſs; unto which Ruler doth belong two Sights with ſliding Loops both of one length, and double ſighted, the one having a Slit below, and a Thred above, and the other a Slit above, and a Thred below, ſerving to look backward and forward at pleaſure, without turning about the Inſtrument when the Needle is at quiet: What advantage theſe Back-Sights will make to the Surveyor, one days experience will ſatisfie. Likewiſe there is upon this Index or Ruler ſeveral Lines of equal parts, and Chords, for the laying down the Plot of any Field or Incloſure. There doth belong likewiſe to this Table a Box and Needle, with a Card, ſuch a one as I have deſcribed that doth belong to the Semicircle: Alſo you muſt have a Socket of Braſs to be ſcrewed on the Backſide of the Table, to put in the Head of your Three-legg'd Staff; this Staff ought to be joynted in the middle, ſo that it may be more portable.

CHAP. IV.

The Deſcription of Mr. Gunter's *Decimal Chain.*

FOr the better avoiding many Inconveniences, I would have the Surveyor to have his Chain made of good and round Wyer: The Chain doth contain in length Four Statute Poles or Perches; and this is likewiſe divided into an hundred equal parts, which we call Links, each Link containing in length 7 Inches and $\frac{92}{100}$ parts of an Inch, and ſomething more; at the end of every Ten Links, there is a Braſs Ring, for the better taking of an account of the Number of Links that ſhall remain above the number of Chains: In the meaſuring of any Diſtance, there doth belong a certain number of ſmall Arrows, or the like Sticks that are ſharp at one end; the uſe of theſe being thus, When you are in the middle of a Field, to take the Plot thereof, when you ſend your men to meaſure how far it is from your Inſtrument to the Angle of the Field, he that goes formoſt takes theſe Arrows in his hand, and at the end of the Chain doth ſtick down one of them, and ſo on till he hath gone the length of the place; and he that doth follow him that leads the Chain, takes up the Arrows; and ſo by that means he comes to know how many Chains it is in length, by the number of Arrows that he hath in his hand that doth follow the Chain.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N
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☞ Where note, They that go with the Chain, muſt go in a ſtraight Line; to do which, when you ſee him that doth lead the Chain ſtick down his Arrow, you may look through your Sights, and if you ſee him and the Angle in a ſtraight Line, then they go right, elſe not; one hour's practice will make the Surveyor perfect in this thing: Note alſo, when we account and ſet it down, we ſet down Chains and Links.

CHAP. V.

A Deſcription of the Protractor, *and the Scale thereof.*

A *Protractor* conſiſteth of Two Parts, *viz.* the Scale and the Semicircle; it muſt be made of Braſs, to contain in length from A to B about five Inches (or more, if you will have it made larger) and in breadth, from L to C, ſomewhat more than three quarters and a half, which place muſt be divided in the middle both ways by the Lines A B, and L C, cutting each other at right Angles in the Point D: As upon a Center deſcribe the Semicircle N C S, then this Semicircle is divided into 180 equal Parts or Degrees, numbring them from Five to Tens, to 180, and back again to 360, as you may ſee in the *Fig.* the firſt Number 180 will ſerve for the Eaſt ſide, and the latter 360 for the Weſt ſide of the whole Circle; then let the Edges of the Scale, as E B, A F and F E be made very ſtraight and ſmooth, and exactly paral-

lel to the edges of the Plate of which the *Protractor* is made; then divide the parallel Degrees at either end of the Scale, between E B and F A, and let the Scale of 12 to an Inch be placed on the edge E F, and let the Square about the Center D, be cut quite out, that the Point (in protraction) may be found, on which the Protractor muſt be laid: And here note, That the Points B D A are in a direct Line, being the Meridian Line, and ſo the Guide of all the reſt for the uſe of this Protractor; in protracting you muſt have a fine Needle put into a piece of Box or Ivory neatly turned; to find your Center, note your Degrees, and make ſmall Marks in drawing your Plots, which we will call a protracting Line.

CHAP. VI.

The Manner of ordering a Field-Book *to be uſed when you work with the* Semi-circle.

SInce it hath been our Buſineſs hitherto to provide us of what is neceſſary in the Practice of Surveying, we ſhould be very much to blame, ſhould we forget this; it being ſo uſeful a thing: In the making of which Book, obſerve this Direction; let it be a Quantity of Paper more or leſs, bound up in a Long *Octavo* or a *Semi-Folio*, like an Alphabetical Debt-book (which is beſt) let it be Ruled towards the Left Hand of every Page with ſeven Lines, ſo ſhall you

you have ſix Columns; the firſt ſerving to note the Degrees cut by the Index of your Semicircle; the Second, for the Parts of a Degree called Minutes; the Third for the Chains; the Fourth for the Links; the Fifth for the Off-ſets to the Right; the Sixth for the Off-ſets to the Left.

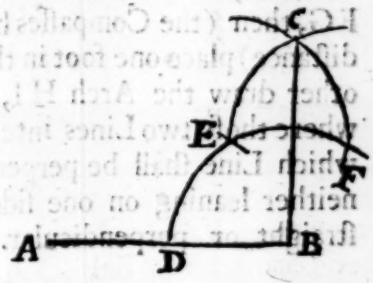
CHAP. VII.

Containing certain Practicals of Geometry, *fit to be known before you enter upon Surveying.*

PROP. I.

How to erect a Perpendicular on the End of a Line given.

LEt AB be a Line given, and from the Point B let it be required to raiſe the Perpendicular BC, firſt open your Compaſſes to any Diſtance; as to BD, then place one Foot in B, and with the other deſcribe the Arch DEF, then place one Foot in D, and with the other make the Mark in the Arch at E, then removing the Compaſſes to E, deſcribe the Arch CF, then



then remove the Compaſſes to F, and deſcribe the Arch C E; then from the Interſection of theſe two Arches, draw the Line C B. which is the Perpendicular required.

PROP. 2.

How to erect a Perpendicular upon any Point in a Line aſſigned.

LEt a A B be a Line given, and from the Point C, it is required to draw a Line perpendicular to the Line A B; Firſt open your Compaſſes to any ſmall diſtance, and place one Foot in C, then turn your Compaſſes about, and deſcribe a dark Circle, and note where that Circle doth cut the Line A B, and you ſhall find it will in 2 places, *viz.* in D and E; then opening the Compaſſes to any greater diſtance, place one Foot in the Point E, and with the other Foot draw the Arch F G, then (the Compaſſes being kept open to the ſame diſtance) place one foot in the point D, and with the other draw the Arch H I, then from the Point K, where thoſe two Lines interſect, draw a Line to C, which Line ſhall be perpendicular to the Line A B, neither leaning on one ſide or other, but directly ſtraight or perpendicular.

PROP.

PROP. 3.

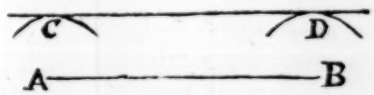
How to let a Perpendicular fall upon a Line from a Point assigned.

LEt A B be a Line given, and let the Point C be the Point from whence I would let fall my Perpendicular, first open your Compasses to any distance, so it be greater than C D, and place one Foot in the Point given C, and with the other draw the Arch E F, then divide the Distance into two equal parts at D, so shall the Line C D be perpendicular to the Line A B.

PROP. 4.

How to draw Parallel Lines.

PArallel Lines are such which being infinitely extended, would never meet; wherefore let A B be a Line given, unto which it is required to draw the Line C D parallel at the Distance A C; having drawn the Line A B upon your Compass to the Distance A C, and placing one Foot in A, describe the Arch C, then removing your Compasses to B, draw the Arch D, then lay a Ruler so, that

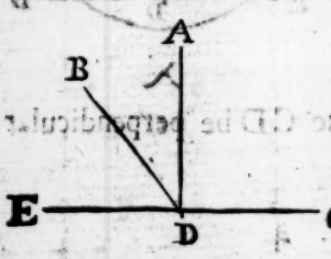


that it may justly touch the top of the Arches C and D, and the Line so drawn, shall be exactly parallel to the Line A B.

PROP. 5.

An Angle which is greater than a Right Angle, is an obtuse Angle; but if less than a Right Angle, it is an Acute Angle.

EVery Angle in general (not being a Right Angle, whether greater or lesser) is called an Oblique Angle; but particularly, if greater than a



Right Angle, 'tis called an Obtuse Angle; if lesser, an Acute Angle; as the Angle B D C, (being greater than the Right Angle A D C) is an Obtuse Angle; for it containeth it and also the Angle A D B; so likewise the Angle B D E is Acute, forasmuch as it is less than the Right Angle A D E; for the Right Angle A D E doth contain both the Angle B D E, and the Angle A D B.

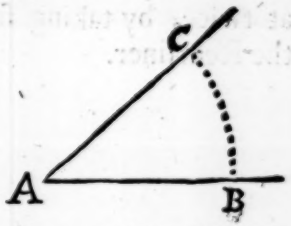
CHAP.

CHAP. VIII.

Of the use of the Line of Chords placed on the Scale before described, and how to lay down an Angle of any Quantity required, or to find the Quantity of an Angle given.

PROP. 1.

FIrst draw a Line at pleasure as A B, and from the Point A let it be required to draw an Angle of 40 degrees; extend your Compasses upon the Line of Chords, from the beginning thereof to 60 degrees, with which distance set one Foot upon the Point A, and with the other draw the prick'd Arch B C, then with your Compasses take 40 degrees (which was the Quantity of the required Angle) out of the same Line of Chords that you took the 60 degrees, and set one Foot thereof upon B, and extend the other to C; Lastly, draw the Line A C, and so the Angle C A B shall contain 40 degrees. I would advise the young Surveyor to be well acquainted with this Chapter; for he will find it will be of good use when he comes to take Heights and Distances; and of laying down of plain Triangles, which I shall shew in the next place, after I have done with this Chapter.

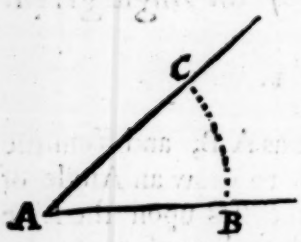


PROP.

PROP. 2.

There being an Angle given, to know what Quantity it is.

LEt CAB be an Angle given, and if it were required to find the Quantity thereof, then as before, open your Compasses to 60 degrees of your Chords, and placing one Foot in A, describe the Arch CB, and measuring the extent upon your Line of Chords from the beginning thereof, you will find it to contain 40 degrees.



☞ Note, if any Angle given or required shall contain above 90 degrees, or the fourth part of a Circle, you must then perform it at twice, by taking first the whole Line, and then the Remainer.

CHAP. IX.

Containing the Explication of the Tables of Sines and Tangents.

Any Arch or Angle of a Triangle containing any Number of Degrees and Minutes being given, to find the Logarithm of the Right Sine or Tangent belonging thereunto.

First, you muſt underſtand that every Circle is divided into Four Quadrants or Quarters, and each Quadrant is divided into 90 degrees, and each degree into 60 Minutes, and the Logarithm, Sines and Tangents for every of theſe degrees and 5 minutes are plainly expreſſed in theſe Tables, and are thus to be found.

When the Number of the degrees given doth not exceed 45 deg. make ſearch for the ſame at the top of the Pages of the Tables entituled *Artificial Sines and Tangents*, and if there be any minutes joyned to the degrees, you muſt find them out in the firſt Column or Margin towards the Left Hand, which is marked with the Letter M; and having ſo done, right againſt thoſe Minutes, under the Title *Sine*, at the Top of the Table, you ſhall find the Log. of the ſaid Sine and Minutes, and under the Title *Tangent*, you ſhall have the Log. of the Tangent of the Arch or Angle deſired. So the Log. of the Sine of 20 degrees and

30 minutes, is 9. 544325, and the Log. Tangent of the ſame Angle is 9. 572738.

But when the Number of the deg. required exceeds 45, you muſt look for them at the bottom of the ſaid Table, and you muſt look for the odd minutes in the firſt Column or Margin towards the Right hand, marked likewiſe with the Letter M, and ſo right againſt theſe Minutes in the Column above the Title *Sine*, and above the Title *Tangent*, you ſhall find the Log. of the ſaid Sine or Tangent of the Angle required. So the Log. Sine of 50 deg. and 20 min. is 9. 886361, and the Log. Tangent of the ſame Angle is 10. 081323. and thus you may find the Log. Sine or Tangent of any other Angle required.

CHAP. X.

To find the Co-Sine *or* Co-Tangent *of any Angle.*

THe *Co-Sine* or *Co-Tangent* of any Angle, is that which others call the Complement of any Angle; or more plainly, the remaining part of that Angle being taken out of 90 deg. Thus the Angle of 40 deg. being taken out of 90 deg. the Complement thereof will be found to be 50 deg. and on the other ſide, if 50 deg. be taken out of 90 deg. it leaves 40 deg. to be the Complement thereof; ſo that theſe Two Angles are the Complements of each other; and ſo you ſhall find the Complements of any other Angle.

Now

Now theſe Complements being of frequent uſe in Trigonometry, it hath been the care of moſt modern Mathematicians ſo to compoſe their Tables of Sines and Tangents, that theſe Complements ſhould be always joyned or coupled together; and therefore Mr. *Gunter* very fitly calls them coſines and cotangents; and this is done by making the Tables of Sines and Tangents to run on from 0 deg. to 45 deg. with their reſpective Titles at the top of the Tables, and then from 45 deg. to 90 deg. they turn back again in order with their reſpective Titles at the bottom of the Table; thus the Sine and Tangent of every deg. and min. in one Column is joyned with its Coſine and Cotangent in the next Column; ſo that without the trouble of ſubſtracting the Angle from 90 deg. you may readily find out the Complement of any Angle in degrees and minutes, or the Log. Sine or Tangent by the Arch, according as you have occaſion: thus the complement of the Angle 40 deg. is 50 deg. the Log. Sine whereof is 9884254, and the Log. Tangent whereof is 10. 076186. So likewiſe the Complement of the Angle 50 deg. is 40 deg. the Log. Sine whereof is 9808067, and the Log. Tangent 9923813, and ſo for any other Angle, the Coſine is ſtill coupled with it in the adjoyning Column.

CHAP. XI.

The Explanation of the Tables of Logarithms.

LOgarithms are Numbers ſo fitted to proportional Numbers, that themſelves retain equal Differences. Theſe Tables of Logarithms (which are at the end of this Book) contain certain Numbers increaſing by an Unit in a continual proportion from 1 to 1000, ſo that any Number under 1000 being given, you may find the Logarithm thereof, or any Logarithm (whoſe abſolute Number exceedeth not 1000) may be found by this Table.

Example 1.

Suppoſe the Number given be 28, you muſt find 28 in the firſt Column of the Table (under the Title *Num.*) and againſt it in the ſecond, you will find 1447158, which is the Logarithm thereof.

Example. 2.

Let it be required to find the Logarithm of 125, ſeek for 125 in the firſt Column under the Title Num. and againſt it in the ſecond you will find 2096910, which is the Logarithm thereof.

CHAP.

CHAP. XII.

Of the joint uſe of the Tables of Sines, Tangents and Logarithms, in the menſuration of the Sides and Angles of right Lined Triangles,

FOraſmuch as the taking of Altitudes and Diſtances depend wholly upon the menſuration of right Lined Triangles, I do think it wholly neceſſary for the young Surveyor to be well acquainted with the knowledge thereof; therefore I ſhall firſt ſhew him the manner of laying down and menſuration of all the Caſes of plain Triangles, and then apply them to the taking of Altitudes and Diſtances. Therefore let us conſider,

1. That all plain Triangles do conſiſt of ſix parts; three Angles, and three Sides.

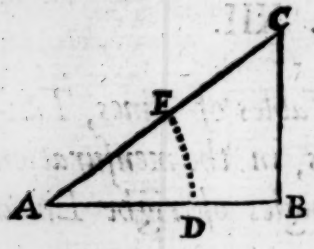
2. That the Angles of a plain Triangle are meaſured by a Line of Chords upon an Arch deſcribed on the angular point; as the Arch D E is the meaſure of the Angle at A.

3. The Sides of a plain Triangle are meaſured by a Line of equal parts.

4. That all Circles are divided into 360 parts, which parts are called Degrees; each Degree is ſubdivided into 60 parts, called Minutes.

5. The three Angles of any plain Triangle are equal to 180 deg.

6. A Triangle is either right angled or oblique angled; a right angled Triangle is that which hath one right angle (which is equal to 90 deg.) as the Triangle A B C is right angled at B, and the other two Angles A and C are alſo equal to 90 deg. becauſe the 3 Angles are equal to 180 deg. and therefore the Angles A and C muſt be the Complement to each other; ſo that if you ſubſtract the Angle A from 90 deg. there will remain the Angle C.



7. In every right angled Triangle the ſide which lieth oppoſite to the right angle, is called the Hypothenuſal, and of the other Two, the one is called the Baſe, and the other the Perpendicular, at pleaſure, but moſt commonly the longeſt of the Two is called the Baſe, and the ſhorteſt the Perpendicular; as in the Triangle A B C right angled at B, the ſide A C is the Hypothenuſal, and A B the Baſe, and A C the Perpendicular.

8. In right angled plain Triangles there are Seven Caſes, and Five in oblique; for the Solution of which, theſe Four Axioms are ſufficient.

AXIOM I.

Of Right Angled Triangles.

In all plain right angled Triangles any of the ſides may be made the Radius, and the other ſides will be the Sines, Tangents or Secants, and look what proportion the ſide put for Radius hath to the true Radius,

dius, or Sine of 90 deg. the ſame proportion hath the other ſides to the Sines, Tangents or Secants by them repreſented.

AXIOM II.

Of Oblique Triangles.

In all plain Triangles the ſides are in ſuch proportion one to the other, as are the Sines of their oppoſite Angles.

AXIOM III.

In all plain Triangles, as the ſum of Two ſides is to their Difference, ſo is the Tangent of the half ſum of their two oppoſite Angles to the Tangent of the Difference of either of them above or under the half Sum.

AXIOM IV.

In all plain Triangles, as the Baſe is in proportion to the Sum of the other two ſides, ſo is the Difference of the two ſaid ſides to the Difference of the Segments of the Baſe.

If any Angle exceed 90 deg. ſubſtract it out of 180 deg. and work by the Sine of the Remainer.

CASE I Fig. 1.

THe Hypothenuſal and Angles being given to find the Baſe and Perpendicular, let the Hypothenuſal be 100 equal parts, and let the Angle at the Baſe A be 30 deg. then the Angle at the Perpendicular C will be 60 deg. by the ſixth Conſideration.

For the laying down of this Triangle.

Firſt you muſt draw your Baſe A B at pleaſure, then upon the Point A lay down the Quantity of your Angle at the Baſe, as you were taught in *Chap.* 8. When you have ſo done, draw the Hypothenuſal A C, it being 100 equal parts, then from the Point C let fall a Perpendicular upon the Baſe A B, then have you done.

Then for to find the length of the Baſe and Perpendicular.

For the Baſe making the Hypothenuſal the Radius.

As the Radius or Sine of 90 *d.* B	10. 000000
Is to the Log. of the Hypothenuſal 100 AC	2. 000000
So is the Sine of the Angle at C 60 *d.*	9. 937531
To the Log of the Baſe AB 86	*x* 1. 937531

The neareſt leſs in the Log. you will find to be 86, which is the length of the Baſe ſought.

The General Rule for working Proportion by Logarithms.

You muſt add the Log. of the Second and Third Numbers together, and from their Sum ſubſtract the Log. of the Firſt, and the Remainer is the Log. of the Fourth ſought, as it doth appear by theſe following Operations.

The Work may be abbreviated when the Radius is not in the firſt place, by taking the Complement Arithmetical of the Log. of the firſt Number, and then adding

adding the Log. of the ſecond and third, and the Complement Arithmetical of the firſt into one ſum; from which abating the Radius (or an Unite towards the left hand) the Remainer is the Log. of the fourth Number.

The readieſt way to find the Complement Arithmetical of any Log. is that of Mr. *Norwood's*, in his *Doctrine of Triangles*; which is thus, To take the Reſidue of the firſt Figure towards the left hand unto 9, and ſo of the reſt until you come to the laſt Figure towards the right hand thereof, and for that laſt Figure you muſt ſet down the reſidue to 10.

Example.

I would know the Complement Arithmetical of the Sine of 40 deg. which is 9.808067, the reſidue of the firſt Figure to the left hand to 9 is 0; of 8 to 9, is 1; of 0 to 9, is 9; of 8 to 9, is 1; of 9 to 9, is 9; of 6 to 9, is 3; of 7 to 10, is 3; ſo the Complement Arithmetical is 0191933. Mark this Rule well, for you will find it of good uſe, and it is eaſily done, as you ſee.

But if the Radius be in the firſt place, then there is no need for taking of the Comp. Arithmetical of the firſt Number, only you muſt cut off the firſt 1 to the left hand thus, 1, and you will have your deſire; as you may ſee in the foregoing operation. The laſt operation was to find the Baſe.

Now

Now for the Perpendicular, the Proportion will run thus.

As the Radius or Sine of 90 *d.*	B.	10.000000
Is to the Log. of the Hypoth.	A C 100	2.000000
So is the Sine of the Angle at	A 30	9.698970
To the Log. of the Perpendicular	B C 50	1.698970

So if you look in the Table of Log. for this last Log. you will find 50, which is the length of the Perpendicular.

CASE II. Fig. 1.

THe Base and Angles being given, to find the Hypothenusal and Perpendicular, let the Base A B be 86 equal parts, and the Angle at the Base A be 30 *d.* the Angle at C being the Complement to 90 deg. is 60 deg.

For the laying down of this Triangle.

First you must draw a Line, and set off the length of your Base A B, then at the end thereof at B, raise a Perpendicular; then upon the other end of the Base at A, lay down the quantity of the Angle at the Base, as you were taught in *Chap.* 8: then draw the Line A C, and your Angle is laid down.

The Operation for the Perpendicular making the Hypothenuſal the Radius.

As the Coſine of the Angle at A 30 *d.co.ar.* 0. 062469
Is to the Log. of the Baſe AB 86 1. 934498
So is the Sine of the Angle at A 30 9. 698970
To the Log. of the Perpend. 50 BC 11. 695937

The neareſt to it in the Table of Log. is the Log. of 50: and here you ſee what benefit it is to take the Complement Arithmetical of the firſt Number; for by that means you ſave Subſtraction.

To find the Perpendicular making the Baſe Radius.

Operation.

As the Radius or Sine of 90 *d.* B 90 10. 000000
Is to the Log. of the Baſe A B 86 1. 934498
So is the Tangent of the Angle at A 30 9. 761439
To the Log. of the Perpend. B C 50 11. 695937

This doth 50 as before.

For the Perpendicular, making the Perpendicular Radius.

Operation.

As the Tang. of the Angle at C 60 *d. co.ar.* 9. 761439
Is to the Log. of the Baſe A B 86 1. 934498
So is the Rad. or Sine of 90 *d.* B 90 10. 000000
To the Log. of the Perpend. BC 50 11. 695937

This doth give 50, as before. I have been the larger upon this Caſe, becauſe I would make it plain to the meaneſt capacity.

To

To find the Hypothenusal.

Operation.

As the Sine of the Angle at C 60 *ar.* 0.062469
Is to the Log. of the Base A B 86 1.934498
So is the Radius or Sine of 90 *d.* B 90 10.000000
To the Log. of the Hypoth. A C 100 1.996967

Here you see that the fourth Number doth want of 100, but this comes by reason that 86 wants a little of the length of the Base; and because I am not willing to trouble the young Learner with Fractions, it being a thing wholly useless in the Practice of Surveying.

CASE III. Fig. 1.

THe Perpendicular and Angles being given for to find the Base and Hypothenusal; let the Perpendicular be 50 equal parts, and the Angle at the Perpendicular C, be 60 deg.

For the laying down of this Triangle.

First draw a Base at Pleasure, and at the Point B raise a Perpend. and set off 50 equal parts from B to C, then at the Point C lay down the Quantity of the given Angle C, as you were taught in *Chap.* 8; then draw the Line C A, and then you have done.

For

For the Baſe making the Hypothenuſal Radius.

Operation.

As the Sine of the Angle A	30 *co. ar.*	0.301029
Is to the Log of the Perpend. B C	50	1.698970
So is the Sine of the Angle C	60	9.937531
To the Log. of the Baſe A B	86	1.937530

To find the Baſe making the Perpendicular the Radius.

As the Radius B 90 *d.* is to the Log. of the Perpendicular B C,
So is the Tangent of the Angle at C 60 to the Log. of the Baſe A B.

For the Baſe making the Baſe the Radius.

As the Tangent of the Angle at A is to the Log. of the Perpendicular B C,
So is the Radius B to the Log. of the Baſe A B.

For the Hypothenuſal.

You may find the Hypothenuſal as you did in the laſt Operation of the laſt Caſe.

CASE IV. Fig. 1.

THe Baſe and the Hypothenuſal being given to find the Perpendicular and Angles; let the Baſe be 86 equal parts, and the Hypothenuſal be 100 equal parts.

For

For the laying of this Triangle down.

First you muſt draw a Line at pleaſure, then make A B 86 equal parts, the length of the given Baſe, then at the Point B raiſe a Perpendicular, then take the length of your Hypothenuſal from your Line of equal parts, and with that diſtance ſetting one Foot of your Compaſſes in the point A, you will find that the other point of your Compaſſes will touch the Perpendicular in the point C, then draw A C your Hypothenuſal, and it is done.

For the finding the Angle at the Baſe, making the Hypothenuſal the Radius, the Proportion will run thus.

As the Log. of the Hypothenuſal A C is to the Radius or Sine of 90 deg. ſo is the Log. of the Baſe A B to the Coſine of the Angle at the Baſe A.

For the Angle at the Baſe, making the Baſe the Radius.

As the Log. of the Baſe A B is to the Radius or Sine of 90 deg. ſo is the Log. of the Hypothenuſal A C to the Secant of the Angle at the Baſe A.

To find the Perpendicular.

This is to be found after the ſame manner as you did in *Caſe* 2. therefore I ſhall ſay no more here, but proceed.

Caſe

CASE V. Fig. 1.

THe Hypothenuſal and Perpendicular being given; to find the Baſe and Angles; let the Hypothenuſal be 100 equal parts, and the Perpendicular 50.

For the laying down of this Triangle.

Firſt draw a Baſe at pleaſure, then at the Point B raiſe the Perpendicular B C, and make it to contain 50 equal parts, the length of the given Perpendicular; then take off from your Scale of equal parts the length of your Hypothenuſal, and ſetting one Foot of your Compaſſes in the Point C, you ſhall find that the other Foot will touch the Baſe at the Point A, then draw A C, and you have done.

To find the Angle at the Baſe, making the Hypothenuſal the Radius, the Proportion will run thus.

As the Hypothenuſal A C is to the Radius or Sine of 90 deg. B, ſo is the Perpendicular B C to the Sine of the Angle at A.

But if you make the Perpendicular the Radius, then the Proportion will run thus.

As the Log. of the Perpendicular B C is to the Radius B, ſo is the Log. of the Hypothenuſal A C to the Secant of the Angle at C. The Angle C ſo found, if you ſubſtract from 90 deg. leaves the Angle at A., Here you ſee that the Angle at C is found by Secants, and there are no Secants in our Tables; but they are made

made thus; Take the Cosine of the Angle that you are minded to find the Secant of, and substract it from the double Radius, and the Remainer will be the Secant of the Angle: or if you have a Secant given, and you desire to know what Angle it doth belong to, you must substract the given Secant from the double Radius, and there will remain the Cosine of the required Angle.

Example.

Let it be required to find the Secant of 40 deg. I look for the Cosine of 40 deg. which is 9. 884254. This Cosine I substract from the double Radius, which is 20. 000000. Thus,

The double Radius is	20. 000000
The Cosine substr.	9. 884254
The Secant of the Angle 40 deg.	10. 115746

Or suppose I had this Secant 10. 115746, to find what Angle it doth belong to, the Work will stand thus.

The double Radius is	20. 000000
The Secant substract.	10. 115746
And there will remain the Cosine of 40 *d.*	9. 884254

the Angle required. So may you do for any other Angle.

Having thus found the Angles, you may find the Base as you did in *Case* 3.

CASE VI. Fig. 1.

THe Base and Perpendicular being given, to find the Angles and Hypothenusal; let the Base be 86 equal parts, and the Perpendicular 50.

For

For the laying down of this Triangle.

First draw your Base A B equal to 86 parts, then at the Point B raise a Perpendicular, and make that equal to 50 equal parts, which will be B C, then from the Point A and C draw your Hypothenusal, and then you have done.

If you will find the Angle at the Base A, *making the Base the Radius, the Proportion will run thus.*

As the Log. of the Base A B: : is to the Radius B,
So is the Log. of the Perpend. B C: : to the Tangent of the Angle A.

Or thus,

As the Log. of the Base A B: : is to the Radius B,
So is the Log. of the Hypothenus. A C: : to the Secant of the Angle A.

But if you make the Perpendidular Radius, then the Proportion will run thus.

As the Log. of the Perpend. B C: : is to the Radius B,
So is the Log. of the Base A B: : to the Tangent of the Angle at C.

Or thus,

As the Log. of the Perpend. B C: : is to the Radius B,
So is the Log. of the Hypothenus. A C: : to the Secant of the Angle C.

Having thus found either of the Angles, the other is found by Substraction from 90 deg. according to the Sixth Consideration.

For

For the Hypothenuſal, if you make the Hypothenuſal the Radius, you may find it by *Caſe* 2.

But if you will find it without finding of the Angle;

Firſt, you muſt (if you will find it by Arithmetick) ſquare both the Baſe and Perpendicular, and add both of their Squares together, and find the ſquare Root of that Sum, and that will be the length of the Hyponutheſal, according to the 47 *Prop.* of the firſt Book of *Euclid.*

Operation.

```
AB 86   BC  50   AB ſquare 7496
   86        50
   ---       ---
   516 ſquare 2500   BC ſquare 2500
  688                                  (Root,
  ----
  7496 the ſum of the ſqu. 9966.0000(99.97 AC
                          18959991  18
                            115  9  ---
                            (1  9  198
                                   ----
                                   1998
```

And thus you ſee that the Hypothenuſal is 9 equal parts; and if you divide one of thoſe parts in to 100 parts, it is 97 of thoſe parts and more; bu it may be found by the Log. alſo, thus; from th doubled Log. of the Baſe, ſubſtract the Log. of th Perpendicular, then find what abſolute Number dot anſwer this Log. to that Number add the Perpendicular, then find the Log. of that Sum, and to th Log. of that Sum add the Log. of the Perpendicular and half the Sum of theſe Logarithms is the Log. o the Hypothenuſal.

Example

Example.

The Log. of the Baſe A B	86	1.934498
The ſame again	86	1.934498
The doubled Log.		3.868996
Subſtract the Log. of the Perpend. B C	50	1.698970
The abſolute Number is	148	2.170026
The Sum of the Perpend. and abſolute Number	198	Log. 2.296665
The Log. of the Perpend. add	50	1.698970
Their Sum is		3.995635
½ is the Log. of the Hypothenuſal	99.9	1.997817

Which in Vulgar Arithmetick is thus; Divide the Square of the Baſe by the length of the Perpendicular, and unto that Quotient you muſt add the length of the Perpendicular, and that Sum you muſt multiply by the length of the Perpendicular, and the Square Root of this Product is the length of the Hypothenuſal.

☞ Note, That if you ſubſtract the Square of the Baſe from the Square of the Hypothenuſal, the Square Root of the Remainer is the length of the Perpendicular; or if you ſubſtract the Square of the Perpendicular from the Square of the Hypothenuſal, the Squre Root of the Remainer is the length of the Baſe.

Of Oblique Plain Triangles.

CASE VII. Fig. 2.

TWo ſides of an Oblique Triangle being given, with an Angle oppoſed to either of them, to find the reſt of the parts thereof. In the Triangle ABC, let the ſide A B be 100 equal parts, and the ſide A C be 70, and let the Angle at B be 30 deg.

For the laying down of this Triangle.

Firſt draw the Baſe A B, and make it equal to 100 equal parts, then at the end of the Baſe at B, lay down the quantity of your given Angle 30 deg. and then draw a Line as if it were to be an Hypothenuſal, then take off 70 equal parts from your Scale, and ſet one foot of your Compaſſes in the Baſe Line at A, and mark where the other doth touch the Line B C, & from that place to the end of the Baſe A, draw a Line, and you have done. For the finding of theſe parts that are to be found, you muſt have two Operations; the firſt muſt be for the Angle at C, and the other for the length of the ſide B C.

And

And first for the Angle C.

Operation.

As the Log of the Side A C 70 eq. *co. ar.*	8. 154902
Is to the Sine of the Angle B 30 *d.*	9. 698970
So is the Log. of the Side A B 100 eq.	2. 000000
To the Sine of an Angle 45. 35.	9. 853872

Which Angle being subſtracted out of 180 deg. leaves the Angle *viz.* C, *viz.* 45. 35, from 180 leaves 134 *d.* 25′ for the Angle at C.

For the Side B C, firſt muſt add the Angle at C to the Angle at B, and their Sum ſubſtract from 180 *d.* leaves the Angle at A.

Then ſay,

As the Sine of the Angle at B, is to the Log. of the Side A C. So is the Sine of the Angle at A, to the Log. of the Side B C.

CASE VIII. Fig. 2.

TWo Angles of an oblique Triangle being given, and a ſide oppoſed to either of them, to find the reſt of the parts thereof, let the Angle at A be 15 *d.* 35′, and the Angle at B 30 deg. and the ſide A B to be 100 equal parts.

For the laying down of this Triangle.

Firſt you muſt draw the Baſe A B, and ſet off 100 equal parts from A to B, then upon the Point A lay down the Quantity of the Angle at A equal to

15 *d.* 35', and then on the Point B lay down the quantity of the Angle at B equal to 30 deg. and where the two Lines do interſect, will be the Angle at C, and then you have done.

For the finding of the reſt of the parts of this Triangle, is in the ſame manner as the laſt; only inſtead of Sides being in the firſt place, here muſt go Angles, and then the proportion will run thus.

As the Sine of the Angle at C, is to the Log. of the Side A B, ſo is the Sine of the Angle at A, to the Log. of the Side C B.

For the Side A C, *it runs thus.*

As the Sine of the Angle at A, is to the Log. of the Side C B, ſo is the Sine of the Angle at B, to the Log. of the Side A C.

☞ Note, in all Proportions of plain Triangles, if an Angle be demanded, a Side muſt be in the firſt place (of the proportion) and the Angle oppoſed to the ſame ſide muſt be in the ſecond place, the ſide oppoſed to the Angle demanded, muſt be in the third place, and the Angle demanded muſt be in the fourth place.

If a ſide be demanded, an Angle muſt be in the firſt place, and it muſt be an Angle that is oppoſed to a ſide given, the ſide given muſt be in the ſecond place, the Angle oppoſed to the ſide demanded muſt be in the third place, the ſide demanded muſt be in the fourth place. Mark this Note well, and you will be able to frame a Canon your ſelf, when you ſee the Triangle laid down, and when the proportions are to be wrought by Sines, but if they be wrought by Tangents, then it is quite otherwiſe.

CASE

CASE IX. Fig. 3.

TWo ſides of an oblique Triangle with the Angle contained between them, being given, to find the other angles and ſide. Let the ſide A B be 100 equal parts, and the ſide A C 80 of the ſame parts, and the contained angle at A be 40 deg.

For the laying down of this Triangle.

Firſt draw a Baſe Line, and make A B equal to 100 equal parts, the length of the given Baſe, then lay down the quantity of the angle at A, upon the point A, then draw the Line A C, and make it equal to 80 of the ſame parts, as you did the Line A B, then from the Line C and B draw the Line C B, and you have done. When you have laid it down, you will find that you will have the ſide C B to find, and the angle B and C; and firſt for either of the angles, you muſt do thus; firſt ſubſtract the given angle from 180 deg. and the remainer will be the ſum of the two angles unknown, and you muſt take half of that ſum, and then add both of the two ſides together into one ſum, and ſubſtract one ſide out of the other, and note their Difference.

Then ſay,

As the Log. of the ſum of the two ſides A B and A C is to the Log. of their Difference,

So is the Tangent of half the ſum of the angles B and C to the Tangent of the Difference of the ſaid two angles above or under the half ſum.

Therefore when you have found the Difference of these two angles, above or under the half sum, if you add this Difference to the half sum, that will be the Angle at C; and if you substract it, there will remain the angle at B.

Then you may find the side B C *thus.*

As the sine of the Angle B is to the Log. of the side A C,

So is the sine of the Angle at A to the Log. of the side B C.

The Triangles might have been found by letting a Perpendicular fall from the point C upon the Base A B, and reducing it into two Triangles, and then you would have in one Triangle the angle at the Base, and the angle at the Perpendicular, and the Hypothenusal A C to find the Perpendicular and Base. Then if you substract the Base found from the first Base given, there will remain the Base of the other Triangle; then will you have in the second Triangle the Base and Perpendicular, to find the angle at the Base; and if you substract the angle at the Base from 90 deg. there will remain the angle at the Perpendicular: this angle at the Perpendicular so found, added to the former angle at the Perpendicular, doth give the angle at C. Note, the former angle at the Perpendicular was found by substracting of the angle at A from 90 deg. then when you have found these angles, then you may find the side B C (having opposed sides and angles) as you see in *Case* 8.

CASE

CASE X. Fig. 4.

HAving the Three Sides of an Oblique Triangle, to find the Angles.

Let the ſide A B be 100 equal parts, and the ſide A C be 80, and the ſide C B 64.

For the laying of this Triangle down.

Firſt you muſt draw a Baſe, and make it equal to 100 equal parts, then take off your ſide A C from the ſame Scale as you did the Baſe, and with that diſtance ſetting one foot of your Compaſſes in the point A, with the other make a ſmall Arch, then take off the length of your ſide B C, and ſetting one foot of your Compaſſes in the point B, and with the other interſecting the ſaid Arch, and where theſe two Arches do interſect, is the place of the angles at C; therefore from that place draw B C and A C, and you have done.

For the finding of either of the Angles.

Before you can find an angle, you muſt reduce this oblique Triangle into two right-angled Triangles, which is done thus; Firſt add the ſide A C, and the ſide B C together into one ſum, and that will be the length of the Line A D, then ſubſtract the ſide C B from the ſide A C, and there will remain a part of the ſide A C (*viz.*) the Line A E, which is their Difference.

Then

Then ſay,

As the Log. of the true Baſe A B, is to the Log. of the ſum of the ſides A C and C B (*viz.*,) A D, ſo is their Difference, *viz.* A E to the Log. of part of the Baſe A O, which part being ſubſtracted from the whole Baſe, and upon the middle of the remainer is the place where the Perpendicular muſt fall that will reduce this Triangle into two right angles, *viz.* the right-angled Triangle B D C, and the right-angled Triangle A D C, thus.

The length of the Baſe A B is	100
The part found A O ſubſtract.	23
The Remainer O B	77
The half thereof is B D	38 ½

Which is the place where the Perpendicular muſt fall, and is the Baſe of the leſſer Triangle B D C; then if you ſubſtract this leſſer Baſe B D from the whole Baſe A B, there will remain the greater Baſe A D of the Triangle A D C, then have you the Baſe and Hypothenuſal in each Triangle, to find an angle, which you find by the Fourth Caſe. Then if you add both the angles of the Perpendicular together, their ſum will be the angle at C.

Operation.

As the Log. of the ſide B C	64 *co.ar.*	8. 193820
Is to the Radius or ſine of 90 *d.*	90 *d.*	10. 000000
So is the Log. of the Baſe B D	38 ½	1. 585461
To the ſine of the ang. at the Perp.	36. 59	9. 779281

Whoſe Compl. to 90 is the angle at B, *viz.* 53 *d.* 1 '.

In the greater Triangle.

As the Log. of the ſide A C	80 *co. ar.*	8.096910
Is to the Radius or fine of 90 *d.*	90	10.000000
So is the Log. of the Baſe A D	61 ½	1.788875
To the fine of the ang. at the perp.	50. 15	9.885785

Whoſe Compl. to 90 *d.* is 39. 45, the angle at the Baſe A.

The angle at the Perpendicular is	36. 59
The angle at the Perpendicular is	50 15
Their ſum is the angle at C	89. 14

CHAP. XIII.

How to place the Semicircle when you go to take an Altitude.

WHen you come to any convenient place where you intend to take the Altitude you deſire, you muſt turn the Arch downward, and with a ſtring and plummet ſee that the two fixed Sights ſtand horizontal; which to do, is no more than thus, Let the ſtring be made faſt at the Center of the Semicircle, and let the plummet hang down, and when it doth play againſt 90 deg. then are your two fixed Sights horizontal, and there ſcrew it faſt; then is it ſet fit to take any Altitude.

CHAP.

CHAP. XIV.

How to take an acceſsible Altitude by the Semicircle.

LEt DC in *Fig.* 5. be a Tower whoſe height is required.

Having placed your Inſtrument (as you were taught in the laſt Chapter) at A, then lift your Index up or down till through the Sights thereof you eſpy the very top of the Tower at C, and obſerve what degree the lower part of the Index doth cut, and that will be equal to the angle at A 35 deg. then meaſure the diſtance from the place of ſtanding, *viz.* A to the Baſe or Foot of the Tower D, which I find to be 100 Yards, then have you the angle at the Baſe A, and the Baſe AB, and the right-angle at B, to find the height of the Tower or Perpendicular DC, which you may find by the Second Caſe of *Plain Triangles.*

Operation.

As the Coſine of my angle obſerved A,
Is to the Log. of the Diſtance from the Tower AD,
So is the ſine of the angle obſerved A,
To the Log. of the Height of the Tower DC,
Which you will find to be 69 Yards.

☞ Note, That you muſt add the height of your Inſtru-

Inſtrument to the height of the Tower found, and that will give you the true height of it, becauſe your Inſtrument being Horizontal, doth leave ſo much of any Building below it as it is high.

CHAP. XV.

How to take an inacceſsible Altitude at two Stations.

LEt D C in *Fig.* 5. be a Tower, and let it be required to find the height thereof.

Having planted your Inſtrument at B, direct the ſight of your Index to C, the top of the ſaid Tower, and mark where the Index doth cut the Limb of the Inſtrument, and you will find it to be 22 deg. and that will be the quantity of the angle at B, and by reaſon of ſome Water or ſuch like thing, you cannot approach to the Baſe of the Tower, you muſt go as near it as you can; which let be A, then meaſure the Diſtance B A, and you will find it to be 73 yards; then ſet up your Inſtrument again at A as you did at B, and there obſerve as you did then, and you will find the angle at A to be 35 deg. which known, you may conſider that the angle A obſerved at the ſecond Station, being 35 deg. the Complement thereof to 90 deg. is 55 deg. the greater angle at C, and likewiſe knowing the angle at B to be 22 deg. the Complement thereof to 90 deg. is 68 deg. and if from this 68 deg. you ſubſtract the greater angle at C, it will leave 13 deg.

deg. to be the leſſer angle at C, then will you have firſt the angle at B 22 deg. and the leſſer angle at C 13 deg. and the Diſtance B A 73 Yards, to find the length of the ſide A C, which you may do by *Caſe* 8 of right-lined plain Triangles, thus;

As the Sine of the leſſer angle at C,
Is to the Log. of the Diſtance B A,
So is the Sine of the angle at B,
To the Log. of the Side A C.

Which if you work as you were taught in *Caſe* 8 it will be found to be 122 Yards, then muſt you have a ſecond Work in the Triangle A B C, in which you have given firſt the angle at A 35 deg. Secondly the greater Angle at C, 55 deg. Thirdly, the Side A C 122 Yards, to find the ſide B C the Altitude of the Tower required.

Wherefore ſay again, according to *Caſe* 1.

As the Radius or Sine of 90 deg. D,
Is to the Log. of the Hypothenuſal A C, 122,
So is the Sine of the angle at A, 35 deg.
To the Log. of the Perpendicular D C. Which will be found to be 69 Yards, as before.

CHAP

CHAP. XVI.

How to take the Altitude of a Tower ſtanding on a Hill.

FIrſt, By the former Rules you muſt take the Altitude of both Hill and Tower together at one or two ſtations, as convenience will give you leave. When you have ſo done, you may take the Altitude of the Hill by it ſelf, and ſubſtract the height of the Hill from the height of both Hill and Tower, and there will remain the height of the Tower by it ſelf. Many are the Concluſions of this nature that may be performed with much celerity and exactneſs; but foraſmuch as the former are the moſt neceſſary, I ſhall not trouble my ſelf to blot much Paper about it, ſeeing that there are many things that are more needful; and if thoſe that do but well underſtand what I have written about Trigonometry, may well be able to take any Altitude whatſoever. As for the protracting of the Work of the three laſt Chapters, I think it but labour loſt if I ſhould blot Paper about it; for I have ſhewed how to lay down any Triangle by the Line of Chords and equal parts already, in the Doctrine of Triangles: and if you conſider that all Altitudes are but parts of Triangles, you will find it very eaſie.

CHAP.

CHAP. XVII.

How to take an inacceſsible Diſtance at tw Stations, not regarding whether the tw Stations and Diſtance required make Right Angle. Fig. 6.

LEt A and B be two Stations, from either of whic it is required to find the Diſtance of the Tre at C.

Having placed your Inſtrument at B, the Index l ing upon the Diemeter or no degrees, direct you Sights to C, and there make faſt your Inſtrument then turn your Index about, till through your Sight you eſpy your ſecond Station at A, noting the degree cut by the Index, which you will find to be 85 de then moving your Inſtrument to A, there make Obſe vation.

Again, By directing your Sights firſt to B, and the to C, you will find the degrees cut by the Index to b 50 deg. ſo in the Triangle A B C you have two an gles given, *viz.* the angle A and B, and by conſe quence you have the third Angle C 45 deg. it being the Complement of the other two to 180 deg. by th *6th* Conſideration; and likewiſe you have given th Diſtance A B 70 Yards, and you are to find the D ſtance A C and B C, which you may perform by th *Eighth Caſe* of the foregoing Triangles.

For

For,

As the Sine of the angle at C 45 deg.
Is to the Log. of the Diſtance of my two Stations 70 yards,
So is the Sine of the angle at A 50 deg.
To the Log. of the Diſtance of the Tree from my firſt Station B C 76.

By the ſame Rule you may find the Diſtance A C.

For,

As the Sine of the Angle at C 45 deg.
Is to the Log. of the ſtationary diſtance A B 70 yards,
So is the Sine of the angle at B 85 deg.
To the Log. of the Side A C, the diſtance of the Tree.

From my ſecond Station I might have ſhewed how to find theſe Diſtances by laying your Index upon a right angle; but it being ſo eaſie for thoſe that can do this laſt Propoſition, I think it is unneceſſary for me to do.

CHAP. XVIII.

How to protract or lay down a Diſtance thus taken upon Paper or Paſtbord, by the help of your Protractor *or Line of Chords.*

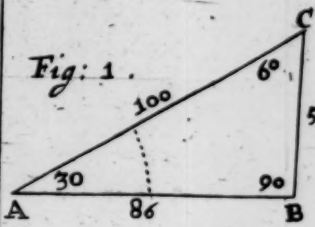
SUppoſe it were required to draw upon Paper or Paſtbord the Symetry or Proportion of the Diſtance laſt taken,

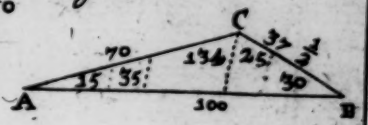
Firſt draw a Line at pleaſure, as B C, then upon the end thereof, as at B place the Center of your Pro- *Fig: 6*

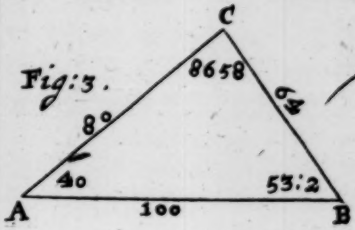
Protractor, and lay the Line A B upon the ſame di
rectly upon the Line B C, then becauſe the angle tha
I did find there, was 85 deg. againſt 85 deg. of your
Protractor, make a Mark upon your Paper, with your
protracting pin, then draw the Line B A, upon which
Line from B to A ſet off 70 equal parts from any o
your Scales (repreſenting 70 yards, the Diſtance o
your two Stations) then remove your Protractor to
A, placing the Line A B of your Protractor directly
upon the Line A B on your Paper, and becauſe the
angle at A was 50 deg. you muſt make a Mark upon
your Paper juſt againſt 50 deg. of your Protractor, &
draw the Line A C & you will find it will cut the Line
B C in the point C; then if you meaſure the length
of the Lines A C and B C by the ſame Scale of equal
parts from whence you took off the 70 yards, *viz.* the
Line A B, you will find the length of the Line A C to
contain 99 yards, and the Line B C to contain 76
yards, exactly agreeing with the former Calculation
of the laſt Chapter.

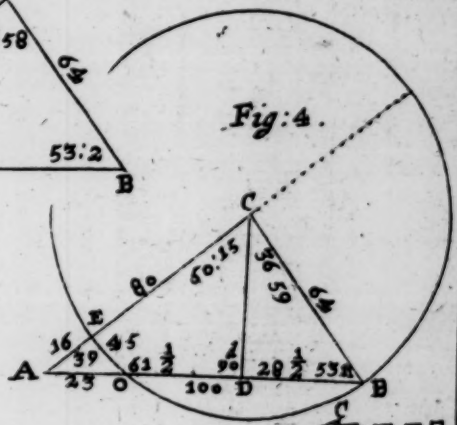
And here the Surveyor cannot but be abundantly
ſatisfied to ſee the agreeing of his Operations, conſi
dering what Harmony there is between Arithmetical
Calculation and Geometrical Projection.

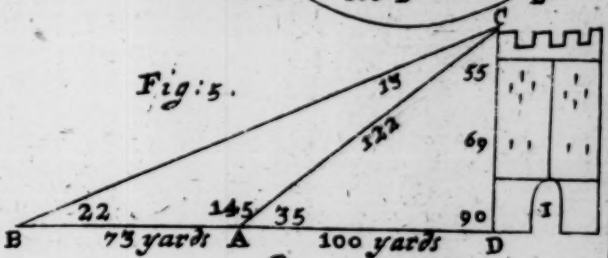
CHAP

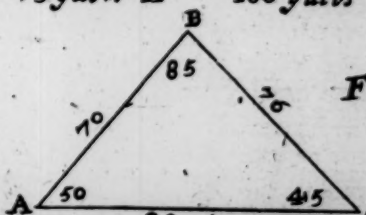












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CHAP. XIX.

How to find the Horizontal Line of any Hill or Mountain.

THis Propoſition differeth little or nothing from thoſe before ſhewed in the taking of Altitudes. Wherefore admit you ſhould meet with a Hill or Mountain, as the Hill *Fig.* 7. and it were required to find the length of the Line A B, on which the Mountain ſtandeth, firſt place your Inſtrument at A (in the ſame manner as you were to do when you were directed to take the Altitude of any Tower) then let one go to the top of the Hill at C, and there place a Mark, which muſt be ſo much above the top of the Hill as the Inſtrument is above the ground where it ſtandeth, then move your Index up and down till through the Sights thereof you ſee the top of the Mark at C, then note the degrees cut by the Index, and that will be the quantity of the Angle at A, which let be 50 deg. then by conſequence the leſſer angle at C will be 40 deg. it being the Complement of the other to 90 deg. then meaſure the ſide of the Hill A C, which ſuppoſe to be 346 yards, then in the Triangle A D C you will have given firſt the ſide A C 346 yards. Secondly, the angle at A 50 deg. Thirdly, the leſſer angle at C 40 deg. together with the right angle at D, to find part of the Line A B, *viz.* A D. Which to perform, ſay

As the Radius or Sine of 90 deg. 10. 000000
Is to the Log. of the side A C 346 yards. 2. 539076
So is the Sine of the lesser angle at C 40 *d.* 9. 808067
To the Log. of the side A D 222 yards. 2. 347143

Then because the Hill descends on the other side, you must place your Instrument at C, and cause a man to go down to the bottom of the Hill at B, and there place a Mark so much above the ground as your Instrument is above the top of the Hill; this done, order your Instrument in all respects as you did at A, then move your Index up and down, till through your Sights you espy the Mark at B; then note the degrees cut by the Index, which will be 50 deg. the greater angle at C, the Complement of which to 90 deg. is 40 deg. the measure of the angle at B, then measure down the Hill to B, and you will find it to be 415 yards; then have you the angles C and B, and the Hypothenusal C B, to find the length of the Line B D, which to obtain, say by the first Case of *Plain Triangles*,

As the Radius or Sine of 90 deg. 10. 000000
Is to the Log. of the Hypoth. C B 415 yar. 2. 618048
So is the sine of the angle at C 50 deg. 9. 884254
To the Log. of the side B D 318 yards. 2. 502302

This 318 yards, the length of the side BD, being added to 222, the length of the Side A D, doth give the length of the whole Line A B, the Horizontal Line of the Hill.

If you be minded to find the Perpendicular height of this Hill, it may be found by the first Case of right angled plain Triangles.

☞ Note, That when you come to protract a Field, you must (if there be a Hill in it) protract the Line AB instead of the Hypothenusal Lines A C and C B.

CHAP. XX.

How to take the Distance of several Places from your place of standing; and their Distance from each other; it being of excellent use to draw a Plot of the most considerable Marks or Bounds of a Town, Mannor or County.

REpair to some place from which you may discern all those places whose distance you require; at which place plant your Instrument exactly level, then move your Index about till through the Sights you espy your first Mark, and then observe what degrees it doth cut on the Limb of the Semicircle, which degrees note down in your Field-Book, then turn your Index to your second Mark, and there note the degrees cut, as before; and set them down, then direct your Sight to your third Mark, and note them down as before; and so do if there be never so many, till you have gone over them all.

Then for your second Observation, make choice of some other convenient place, from whence you may discern all the Marks as before; which stationary distance let be as large as your ground with convenience will permit, and so situated that the Index lying on the Diameter of your Semicircle at your first station, through the Sights thereof you may perceive

your ſecond ſtation; and likewiſe at your ſecond you may diſcern your firſt; ſo that in both ſtations the Diameter of the Semicircle may be in a right Line; at which ſecond ſtation you muſt make obſervation in all reſpects as before, by noting your degrees cut, and ſetting of them down in a Book by themſelves, making a diſtinction between your firſt and ſecond ſtations, as alſo Letters to your ſeveral Marks, as A B C D E, *&c.* at both ſtations, ſo that you may not miſtake. When you come to protract, let CDEF be four ſeveral Churches, or any notable Marks, and let it be required to find the diſtance from either of your ſtations A or B, and alſo their diſtance from each other.

Fig. 8

Make choice of your firſt ſtation at A, where placing your Inſtrument, direct your Sights to your firſt Mark at D, and ſuppoſe your Index cuts 100 deg. which 100 deg. muſt be noted in your Field-Book, as you ſee here following with the Letter D, ſignifying your firſt Mark, then direct your Sights to E, your ſecond Mark, and ſuppoſe the deg. cut to 120 deg. which muſt be likewiſe noted in your Field-Book as before, with the Letter E, to ſignifie your ſecond Mark, then turn your Index about till through the Sight you eſpy your third Mark at F, the Index cutting 130 deg. which you muſt note down in your Field-Book as before, with the Letter F, to ſignifie your third Mark; this done, turn your Index about till through the Sights you eſpy your fourth Mark at C, the Index cutting 150 deg. note this down alſo in your Field-Book with the Letter C.

This done, bring your Index to the Diameter of your Semicircle, that through your Sights you may eſpy your ſecond ſtation at B, and meaſure the diſtance of your ſtation AB, which let be 640 Rods, then

then bring your Inſtrument to B, and the Index lying on the Diameter thereof, move the Inſtrument about till through the Sights you eſpy your firſt ſtation at A, and there fix your Inſtrument, then move your Index about till through the Sights you eſpy your firſt Mark D, the Index cutting 40 deg. which note in your Field-Book, as you did at your firſt ſtation, then direct your Sight to E, the ſecond Mark, the Index cutting 60 deg. which note down in your Field-Book alſo as you did before; ſo do you for all the Marks, and then the Work will ſtand thus, as you ſee.

		deg.	*min.*	*Complements to 180 deg.*	
The firſt ſtation A	D	100	00	80	00
	E	120	00	60	00
	F	130	00	50	00
	C	150	00	30	00

Your Stationary Diſtance 640 Rods.

		d.	*m.*
The ſecond ſtation B	D	40	00
	E	60	00
	F	80	00
	C	20	00

By the help of this Table of your Obſervations, you may at any time protract the ſame on Paper or otherwiſe, and making a Scale of equal parts anſwerable to the parts of your ſtationary diſtance, you may with your Compaſſes meaſure the diſtance of any of theſe Marks one from another, or from either of your ſtations; the manner of protracting whereof is ſhewed in the next Chapter.

CHAP. XXI.

How to protract the former Observations upon Paper, and to make a Scale to measure any of the Distances.

DRaw a Line at length, as A B, and let the two ends thereof A and B represent your two stations; then upon A your first station lay the Center of your Protractor with the Meridian Line thereof (which is noted with A B) directly upon the Line AB, then lay the Table of your Observation before you, and perceiving thereby that at your first observation your Index cut 100 deg. you must with your protracting Pin make a Mark against 100 deg. of your Protractor; then again seeing at your second observation the Index cut 120 d. therefore with your protracting pin you must make a Mark on your Paper against 120 deg. of your Protractor. So must you do for all the rest of your first Observations on your first station; then from A through the Marks made on the Paper, draw the Lines A D, A E, A F, A G; then remove your Protractor to B, which signifies your second station, laying the Meridian Line thereof upon the Line A B, and note the angles of your Observations made at your second station in all respects as you did those of your first station.

At the first Observation of your second station the Index cut 40 deg. therefore with your protracting pin

make

make a Mark upon the Paper againſt 40 deg, of your Protractor, and the degrees cut at your ſecond obſervation were 60 deg. therefore make a Mark againſt 60 deg. of your Protractor; and ſo muſt you do for the other Obſervations: Then from the point B, through the fore-made pricks of this laſt Obſervation, draw ſtreight Lines till they interſect thoſe Lines before drawn from A, which will be in thoſe points D, E, F, C, which four points bear juſt proportion with the four Marks which you obſerved in the Field. Theſe Diſtances may be found by the *Doctrine of Plain Triangles.* Thus firſt you muſt conſider the angle you firſt obſerved at the firſt ſtation was 100 deg. the Complement to 180 is 80 deg. which will be the angle D A B; then the angle at the firſt Obſervation of the ſecond ſtation B was 40 deg. which will be the angle D B A, the Complement of theſe two angles to 180 deg. will be 60 deg. the angle at D; then have you the angle D A B, and the angle D B A, and the angle D with the ſide A B 640 Rods, to find the ſides D A and D B.

Then ſay for the ſide D B

As the Sine of the angle at D	60 *d. co. ar.*	0. 062469
Is to the Log. of the Side A B	640	2. 806179
So is the Sine of the angle D A B	80	9. 993251
To the Log. of the Side D B	728	2. 861899

For the Side D A.

As the Sine of the angle at D	60 *d. co. ar.*	0. 062469
Is to the Log. of the Side A B	640	2. 806179
So is the Sine of the angl. D B A	40	9. 808067
To the Log. of the Side D A	475	2. 676715

Thus may you find the distance of all the rest of the places with ease, and note down in your Field-Book all the distances of the places from both of your stations; and they will stand thus;

D, E, F, C	is distant from my first station A	475, 640, 822, 286	Rods.
D, E, F, C	is distant from my second station B	728, 640, 640, 408	Rods.

So having found these distances, you may protract these Marks more true than by the angles; for when the angle at the Mark is sharp, then it is a hard matter for any one to lay them down true; but this way (by the intersection of two Lines where they trust not to angles) they may. To perform which, do thus, first draw a Line at pleasure, and make A B equal to 640 equal parts, which will represent your two stations, then take of 475 (the distance of D from A) from the same Scale of equal parts as you took the 640, and with that distance setting one foot of your Compasses in the Point A, with the other describe a dark Arch, then take off 728 from off the same Scale of equal parts as you did the rest, it being the distance of D from your second station B, and set one foot of your Compasses in the point B, and with the other intersect the dark Arch made before, and where this Arch is intersected, is the place where the Mark at D should stand; then take off 640 from your Scale of equal parts,

rts, and ſet one foot of your Compaſſes in the point , and with the other deſcribe another dark Arch, en take off 640, the diſtance of E from B your ſe- nd ſtation, and ſet one foot of your Compaſſes in e point B, and with the other interſect the laſt rk Arch made, and the interſection will be the place here the Mark E ſhould be; then take off 822 (it ing the diſtance of F from A) from your Scale of ual parts, and ſet one foot of your Compaſſes in e point A, and with the other deſcribe another rk Arch, then take off 640, the diſtance of F om B, and ſetting one foot of your Compaſſes in the int B, with the other interſect the laſt dark Arch ade, and where it doth interſect is the place where e Mark at F ſhould be, then take off 286, the di- nce of C from A, your firſt ſtation, from off the ale of equal parts, and ſetting one foot of your ompaſſes in the point A, and with the other deſcribe other dark Arch, then take off 408, the diſtance C from B, your ſecond ſtation, and ſetting one ot of your Compaſſes at B, with the other interſect e laſt dark Arch made, and that will be the place here the Mark at C ſhould be. This way may by me thought troubleſom; but when you are uſed to erate with the Sines and Tangents, you will find eat delight therein, and it is the exacteſt way that n be wrought. I have been the larger upon this, cauſe it is of great uſe in the Surveying of Counties d Roads; and to protract from angles only (if your ſtance be great) you will go nigh to place your Stee- es ſometimes a Furlong out of its place, if not ore; for a ſmall matter at the angle will cauſe a eat error, and that is a great cauſe that ſome of our ounty-Maps are ſo falſe.

Becauſe

Becauſe ſome may not affect the trouble of wo
ing by the Sines and Tangents in the Tables, I w
give them a general Rule to work any Queſtion
plain Triangles by the Lines of Sines and Tange
and Numbers that are placed on the Scale, which
this; Set one Foot of your Compaſſes upon the f
Term in any proportion, and extend the other po
to the third Term, the ſame extent will reach fr
the ſecond Term to the fourth Term.

☞ Note, That the Line of Numbers ſerves
ſtead of the Log. for indeed they are no more but
Tables of Log. cut upon a line.

Note alſo which way your Compaſſes do go wh
you extend to the third Term; for the ſame w
muſt you turn the Compaſſes when you extend fr
the ſecond to the fourth Term.

CHAP. XXII.

*How to take the Plot of a Field by the h
of the Semicircle at one Station, taken
any part thereof, from whence you m
view all the Angles, and meaſuring fr
the Station to every Angle.*

SUppoſe *Fig.* 9. to be a Field, and you were
quired to take the Plot thereof; firſt you muſt
round the Field, and place Marks in every angle th
of, then making choice of ſome convenient plac

the Field, from whence you may ſee all the angles thereof, which let be O, at which place plant your inſtrument, and turn your Semicircle about till you make your Needle which is in the Box, hang over the Meridian Line of the Card; that done, ſcrew it faſt, then direct your Sights to your firſt Mark at A, and note the deg. cut by your Index, which we will ſuppoſe to be 30 deg. thoſe 30 deg. muſt be noted down in your Field-Book in the firſt Column, then meaſure with your Chain the diſtance from your place of ſtanding to A, your firſt Mark, which ſuppoſe to be 3 Chains and 20 Links; theſe muſt be noted down in your Field-Book alſo in the third and fourth Columns thereof; then direct your Sight to B, your ſecond Mark, and do by that as you did by the firſt in all reſpects, and ſo muſt you do until you have found the angles and ſides of all the Marks that are placed in the angles in your Field, and when you have finiſhed the Work, it will ſtand thus.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Link.*
A	30	00	3	20
B	70	00	4	30
C	120	00	2	00
D	170	00	3	40
E	240	00	3	70
F	300	00	3	10

This Table being laid before you when you go to Protraction, you will find it very ſpeedy and exact. The manner of laying of this Field down follows in the next Chapter.

CHAP.

CHAP. XXIII.

How to protract or lay down upon Paper any Observation taken according to the direction of the last Chapter.

TAke a Sheet of clean white Paper, draw a right Line thereon at length, which ſhall repreſent the Line N S in *Fig.* 9, then make choice of ſome point or other in that Line to repreſent your ſtation or place of ſtanding in the Field; upon which point place the Center of your Protractor, ſo that the Line A B of your Protractor may lie directly upon the Line N S in *Fig.* 9, then laying your Field-Book open before you, and ſeeing that at your firſt Obſervation noted with A, the Index cut 30 deg. then at 30 deg. of your Protractor make a Mark upon your Paper, which Mark let be repreſented with the Letter A.

2. Seeing the degrees cut at your ſecond Obſervation were 70 deg. you muſt make a Mark upon your Paper againſt 70 deg. of your Protractor, which Mark let be B.

3. The degrees cut at your third Obſervation were 120 deg. therefore againſt 120 deg. of your Protractor make a Mark upon Paper, which Mark let be C.

4. The degrees cut by the Index at your fourth Obſervation being 170 deg. therefore againſt 170 deg.

deg. of your Protractor make another Mark upon your Paper, which Mark let be D.

5. Seeing the degrees cut by the Index at your fifth Obſervation do contain 240 deg. (becauſe it is above 180 deg. you muſt therefore turn the Semicircle of your Protractor downwards, the Line A B lying upon the Line N S, as before) you muſt againſt 240 deg. of your Protractor make a Mark upon your Paper, which Mark is ſignified by the Letter E.

Laſtly, the degrees cut at your laſt Obſervation were 300 deg. therefore againſt 300 deg. of your Protractor make a Mark, which will be F.

Having thus protracted all the deg. of your ſeveral Obſervations, you muſt take away your Protractor, and laying a Ruler to the Center O, draw Lines by thoſe points, which Lines will be O A, O B, O C, O D, O E, O F; this done, you muſt obſerve by your Field-Book the length of every Line.

1. As the Line O A, your firſt Obſervation, was 3 Chains, and 20 Links, therefore theſe 3 Chains and Links muſt be taken from off your Scale of equal parts (either the Scale of 100 to an Inch, or the Scale of 100 to half an Inch) and ſet upon your Paper from O to A, ſo ſhall you have the point A upon your Paper.

2. The length of your ſecond Line being 4 Chains and 30 Links, take that off alſo from your ſame ſcale of equal parts as you did the Line O A, and place it from O to B, ſo have you the Line O B.

3. The length of your third Obſervation being 2 Chains, take theſe 2 Chains from off the Scale, and ſet it from O to C.

And in this manner muſt you proceed with all the reſt of the Lines, as O D, O E and O F.

Laſtly,

Laſtly, Draw the Lines A B, B C, C D, D E E F and F A, ſo ſhall you have the exact Figure o your Field upon your Paper.

CHAP. XXIV.

How to take the Plot of a Field by the Semi circle, taken at one Station in any Angl thereof, from whence all the reſt of th Angles may be ſeen by meaſuring from th Stationary Angle to all the other Angles.

LEt A B C D E F G in *Fig.* 10. be a Field, and were required to draw a Plot thereof.

Having placed Marks at the ſeveral Angles there and made choice of an Angle in the ſame to place you Inſtrument, which ſuppoſe at A, where you mu plant your Inſtrument in all reſpects as you were be fore taught, with the Needle hanging directly ove the Meridian Line.

Then direct your Sights to B. and note the deg cut by the Index, which let be 47 deg. and note down in your Field-Book as you were taught before then with your Chain meaſure the Diſtance A B which let be 3 Chains and 10 Links; note this dow in your Field-Book alſo, then direct your Sights to C and note the deg. cut by the Index, which let be 8 deg. noting the deg. down in your Field-Book; mea ſure the Line A C. and you will find it to be 4 Chain an

and 20 Links, which I note down also; and in this manner must you deal with the other Marks DEF and G, and then having noted them all, your collected Notes in your Field-Book must be as you see in the following Table, and then are you fitted for Protraction.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Links.*
B	47	00	3	00
C	88	00	4	20
D	120	00	6	30
E	165	30	4	00
F	193	00	5	00
G	348	45	2	00

CHAP.

CHAP. XXV.

How to protract or lay down any Observation taken, according to the Doctrine of the last Chapter.

HAving collected into your Field-Book the Quantity of your several Angles, and the length of your Lines, you may proceed to Protraction, in this manner.

1. Draw the Meridian-Line S N, then make choice of a point therein, representing your Stationary Angle at A, to which point appply the Center of your Protractor, the Semicircle upward, then laying your Field-Book before you, you may perceive that at your first Observation (which was at B) your Index cut 47 deg. therefore make a Mark against 47 deg. of your Protractor, upon your Paper, and draw the Line A B.

2. The degrees cut by the Index in your second Observation at C, being 88 deg. make a Mark likewise against 88 deg. of your Protractor, and draw the Line A C.

3. The degrees cut by the Index at the third Observation being 120 deg. make likewise a Mark against 120 deg. of your Protractor, and draw the Line A D, and in this manner must you proceed with the rest of your Observations, namely, with the Lines A E, A F, A G.

Having

Having thus finiſhed your Angular Obſervations, proceed now to your Lineal; namely, to the length of your Lines, noted in the third and fourth Columns of your Field-Book. And,

1. Seeing that the length of your firſt Line A B was 3 Chains, you muſt take 3 Chains from off your Scale of equal parts, and ſet it off from A to B.

2. The Diſtance of the ſecond Line A C being 4 Chains and 20 Links, take the ſame Diſtance from off your Scale, and ſet it off from A to C.

3. The diſtance of your third Mark A D, being 6 Chains and 30 Links, take that diſtance from your Scale, and ſet it off from A to D.

In this manner muſt you proceed with all the reſt of the Lines of the Field, were there never ſo many.

Laſtly, If you draw the Lines B C, C D, D E, E F, F G, G A and A B, you ſhall have upon your Paper the exact Figure of the Field.

☞ Note, That when you Place your Inſtrument, you muſt place it at ſome ſmall diſtance from the Angle (for it cannot be expected that you ſhould place it upon the top of the Hedge) and for that reaſon there cannot be any conſiderable difference in the taking of a Plot of a Field ſtanding near the middle thereof, and the ſtanding near an Angle; but ſhould I not have ſhewn how to take the Plot of a Field ſtanding near an Angle, I might have been thought deficient; but to proceed.

CHAP. XXVI. *Fig.* 9.

How to take the Plot of a Field (upon your plain Table) at one Station, taken in any part thereof, ſo that from the ſame place of ſtanding all the reſt of the Angles may be perceived.

HAving placed Marks at the ſeveral Angles of the Field, make choice of ſome convenient place, (it matters not whether it be near the middle, or near an Angle, ſo that you can but ſee all the Marks that are placed in the Angles) there plant your Inſtrument with a Sheet of Paper; ſtretch thereon the Needle hanging directly over the Meridian-Line in your Chart (which you muſt always have regard unto) then making a Mark in any convenient place in your Sheet of Paper, which will repreſent the place where the Inſtrument ſtandeth, lay your Ruler with Sights upon the Mark that you made upon your Paper, and direct your Sights to the ſeveral Angles where you before placed your Marks; then draw the Lines OA, OB, OC, OD, OE, OF, by the ſide of your Ruler upon your Paper, as you direct your Sights to each Mark; then meaſure the diſtance of each Mark from your Station, and take each reſpective diſtance from off your Scale of equal parts, and place it upon its reſpective Line, and ſo make ſmall

Fig: 7.

Fig: 8.

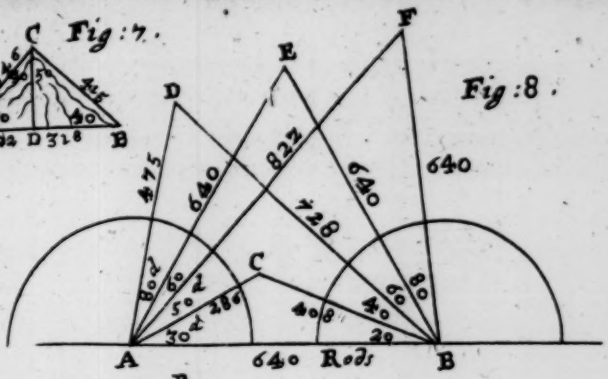


Fig: 9.

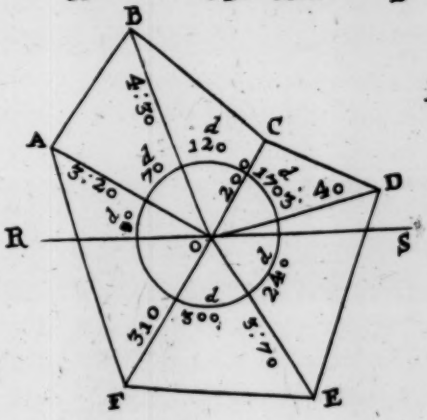
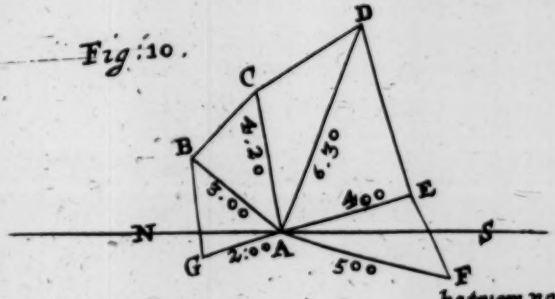


Fig: 10.



between page. 66. 67

ſmall Marks with your Compaſſes or Black Lead; which Marks ſhall repreſent the Angles, A, B, C, D, E, F; then draw Lines from A to B, and from B to C. and ſo of the reſt, and you will have the exact Plot of the Field.

In the ſame manner may you do to take the Plot of a Field near an Angle; therefore I ſhall not blot Paper about it.

CHAP. XXVII.

How to take the Plot of a Field at two Stations, by the Semicircle, and by meaſuring from each Station to the viſible Angles, the Field being ſo irregular, that from no one place thereof all the Angles can be ſeen.

LEt A B C D E F G H I Q in *Fig.* 11. be a Field, and you be required to take a Plot thereof.

Firſt place your Marks in your Angles, as you did before; then make choice of your Stations, which let be O and S, firſt planting your Inſtrument at O, and there fixing it with the Needle hanging over the Meridian-Line, repreſented by the Line R O X, then direct your Sights to A, and finding your Index to cut 50 deg. theſe 50 deg. you muſt note down in your Field-Book as formerly you uſed to do; then

measure with your Chains the length of the Line O A, which you will find to be 2 Chains and 20 Links; which note down in your Field-Book also; then direct your Sights to B, and note the Angle, and measure the Line O B as you did the Line O A, and note it down in your Field-Book.

In this manner you must do with all the Angles visible at your first Station; namely the Angles C D E and F, measuring the distance of every Line as before; this done, direct your Sights to your second Station, and note the degrees cut by the Index, and call that the declination of your second Station from the Meridian-Line, and set it down in your Field-Book, then with your Chain measure the distance of your Stations, which let be 3 Chains; you must note this down in your Field-Book, and call it your Stationary distance; this done, remove your Instrument to S your second Station, and letting the Needle hang over the Meridian-Line in your Chart, then first direct your Sights to F, your last Mark that you observed at your first Station, and note the degrees cut by the Index, and note it down in your Field-Book; then direct your Sights to the rest of your Angles that are visible at your second Station, and do in all respects as you did in your first Station, when you found the Angles A B C D E F, which being collected into your Field-Book according to the Directions of the fore-cited Chapters, they will stand as in the following Tables.

Mark

The Observations taken at the first Station.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Link.*
A	50	00	2	20
B	80	00	3	40
C	140	00	4	00
D	220	00	3	70
E	270	00	4	20
F	330	00	1	00

The Declination of the Stations from the Meridian is 30 deg. and the Stationary distance is 3 Chains.

Observations at the second Station S.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Link.*
F	227	00	00	00
G	297	00	4	00
H	347	15	3	30
I	60	00	4	40
Q	90	00	4	00

CHAP. XXVIII.

How to protract or lay down any Observation taken, according to the Directions of the last Chapter.

First, upon your Paper draw a Line to represent the Meridian-Line in your Plate ROX, and placing the Center of your Protractor upon O, the place of your first Station, laying the Meridian-Line of your Protractor upon the Meridian of your Paper, then make Marks against every of the degrees of the Angles as they are noted in your Field Book, *viz.* against 50 deg. for the first Angle, and against 80 deg. for the second Angle, and so on for the rest, and putting the length of each Line in its proper place; as 2 Chains 20 Links for the Line O A; and so of all the rest within the Observation of your first Station; then because your second Station doth decline 30 *d.* make a prick at 30 deg. and through it draw a Line, which shall represent the declination of your second Station; then take 3 Chains from off your Scale of equal parts, and place it from O to S, then doth S represent your second Station; then placing the Center of your Protractor upon the point S, lay the Meridian of your Protractor upon the Meridian-Line at your second Station (which is no more than a parallel Line drawn to the Meridian-Line at your first Station) this done, make Marks against every of the Angles

gles of your ſecond Station, and ſet off the length of the Lines S G, S H, S I, and S Q, as you are taught in the foregoing Chapters.

☞ Note, That when the degrees that you are to protract, do exceed 180 deg. you muſt turn the Semicircle of your Protractor downwards, and then uſe the degrees that are innermoſt.

The manner of taking a Plot of large Champain Ground by obſerving at many Stations, is almoſt one and the ſame thing as the taking the Plot of a Field at two Stations; and he that can do the one well, cannot be to ſeek in the other.

CHAP. XXIX.

How to take the Plot of a Field at two Stations upon a Sheet of Paper ſtretched on your plain Table, and by meaſuring from the Stations to the viſible Angles, the Field being ſo irregular, that from one place thereof all the Angles cannot be ſeen.

YOu may ſuppoſe *Fig.* 11 to be a Field to be drawn upon your Plain Table; now becauſe you cannot from any one place thereof behold all the Angles at once, you muſt therefore make choice of two Stations, which two Stations let be O and S.

Then upon your Paper make a Mark, as at O, representing your first Station; this being done, place your Instrument at O, the Needle hanging over the Meridian of your Chart.

The Instrument being there fastned, direct your Sights to A, and by the side of your Ruler draw the Line O A; then measure the distance from your place of standing to the Angle A, and set it off from O to A; then direct your Sights to B, and measure the distance O B, and set it off from O to B; then direct your Sights to C, and draw a Line by the side of your Ruler upon your Paper, and set off the distance of O C thereon, and so must you do for all the rest of the Angles that are in sight of your first Station, *viz.* the Angles D E F.

Then direct your Sights to S, your second Station, and by the side of your Ruler draw the Line O S, then measure the distance from O to S.

And by your Scale and Compasses set off your stationary distance upon your Table from O to S.

Having thus made Observation of all the Angles visible from the Station O, draw Lines from O upon your Table, by measuring the distance from O to every one of them; you may then draw the Lines A B, B C, C D, D E, and E F, so have you finished that part from your first Station O.

Then remove your Instrument to S your second Station, and place it in all respects as before, the Needle hanging over the Meridian Line of your Chart, represented in your second Station by the Line T S Z.

Having thus placed your Instrument at S, make observation of the Angles G H I Q in all respects as you did before with the Angles B C D E and F, and having

ing drawn the Lines S G, S H, S I and S Q, and measured their distances from S, you may draw the Lines F G, G H, H I, and I Q; so shall you have upon your plain Table the exact Figure of your Field, no way deviating in proportion from the Field it self.

CHAP. XXX.

How to take the Plot of a Field at one Station by the Semi-circle, in any Angle thereof, by measuring round about the said Field, without crossing the same.

LEt *Fig.* 10. be a Field, and it be required to draw a Plot thereof after the manner above described.

Having placed Marks at the several Angles thereof, and made choice of an Angle to place your Instrument, which suppose at A, and planted your Instrument with the Needle hanging over the Meridian Line of the Chart, turn your Index about till through the Sights you espy your first Mark at B, the degrees cut by the Index will be 47 deg. then directing your Sight to C, the degrees cut by the Index are 88. After this manner must you do by the rest of the Angles of the Field, and note them down in your Field-Book, then measure the length of the side B C, which you will find to be 2 Chains and 75 Links; these 2 Chains and 75 Links you must note down in your Field-Book, then measure the length of the side C D, which will be

be found to be 3 Chains 60 Links; note this down in your Field-Book also, and in this manner proceed until you have found the length of the sides D E, E F F A and A G, and then note them in your Field Book after this manner.

The Marks in the Angles.	*deg.*	*min.*	*Sides.*	*Chains.*	*Links.*
B	47	00	B C	2	75
C	88	00	C D	3	60
D	120	00	D E	4	45
E	165	30	E F	2	36
F	193	00	F A	5	00
G	348	45	A G	2	00

Having collected such a Table, it is no hard matter to project this Field.

CHAP. XXXI.

How to protract or lay down any Observations taken according to the Doctrine of the last Chapter.

HAving your collected Notes by you, first draw a dark Line, which shall represent the Meridian Line, as the Line N S in *Fig.* 10, then placing the Center of your Protractor upon the point A, with the Semi-

Semicircle of your Protractor upwards, then place the Meridian Line of your Protractor upon the Meridian of your Paper, making marks upon your Paper againſt the degrees of every Angle; thus; againſt the Angle obſerved at B, there is 47 deg. therefore againſt 47 on your Protractor make a Mark, and ſo do for all the reſt. Then take the diſtance of B C, which is 2 Chains 75 Links, from off your Scale of equal parts, and placing one Foot of your Compaſſes in B, with the other mark the Line A C in the point C, and draw the ſide B C; then take the length of the ſide C D, and ſet one foot of your Compaſſes in the point C, with the other mark the ſide A D in the point D, and then draw the Line C D; then take off the length of the ſide D E, and ſetting one foot of your Compaſſes in the point D, with the other mark the Line A E in the point E, and draw the Line D E.

After this manner proceed with the reſt, until you have gone round the Field, and drawing the Lines E F, F A, A G, you have the true ground-plot of the Field. This is a very good way to meaſure Lakes or Ponds, becauſe you cannot go croſs a great Lake or Pond, and a Mark may be ſeen at a great diſtance over water. I would adviſe the young Surveyor to be well acquainted with the taking the Plot of a Field this way; for it will be very uſeful in ſurveying great Manners or Counties.

CHAP.

CHAP. XXXII.

How to draw the Plot of a Field at one ſtation taken near any of the Angles thereof, and meaſuring round about the ſame without croſsing from your ſtation to any Angle, by the plain Table.

LEt *Fig.* 12. be a Field to be meaſured, and by reaſon of Water or other Obſtacle you cannot meaſure from your Station to the other Angles, but are forced to plot the ſame by meaſuring round about it, therefore having placed Marks at the ſeveral Angles thereof, and made choice of an Angle in the ſame to place your Inſtrument, which ſuppoſe at A, and having placed your Inſtrument at A (with the Needle hanging over the Meridian-Line) direct your Sights to B, and draw the Line A B; then direct your Sights to C, and draw the Line A C; then direct your Sights to D, and draw the Line A D; then direct your Sights to E, and draw the Line A E; then direct your Sights to F, and draw the Line A F; then direct your Sights to G, and draw the Line A G,

☞ The reaſon that you direct your Sights laſt to G in this and the preceding Chapter, is, becauſe G is below the Meridian Line.

Having thus drawn all the Lines to your ſeveral Marks,

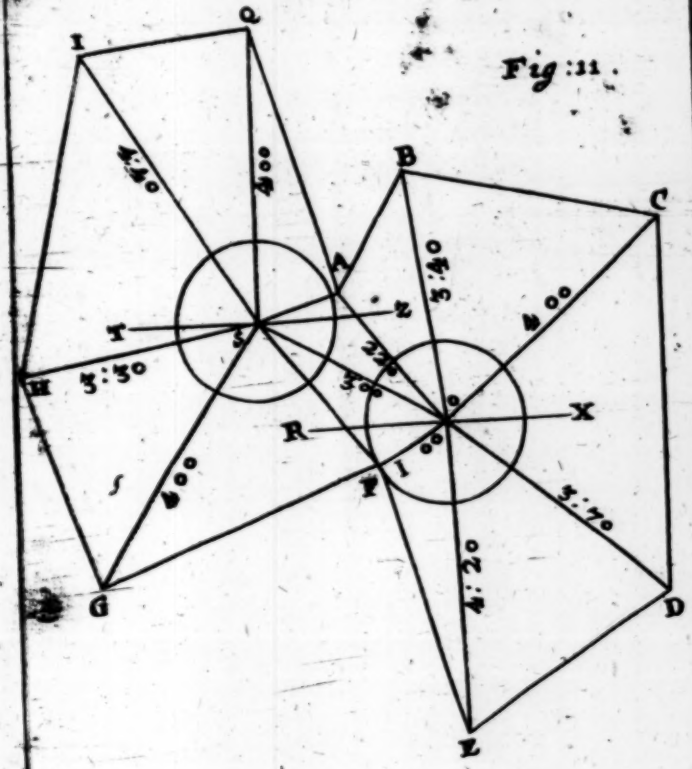


Fig: 11.

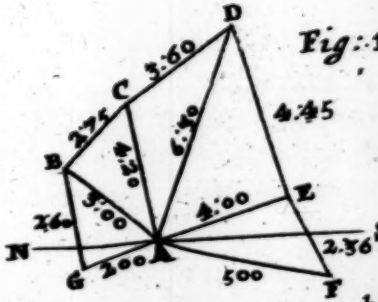


Fig: 12.

between page. 76. 77.

Marks, meaſure with your Chain the diſtance from A to G, which let be two Chains, theſe 2 Chains take off from your Scale; then placing one foot of your Compaſſes in A, with the other croſs the Line A G, with the Arch G, which will be the length of the Line A G; then meaſure with your Chain the length of the Side G B, which let be 2 Chains and 60 Links, theſe take from off your Scale, and placing one foot of your Compaſſes in G, with the other draw the Arch in the Line A B at B, then draw the Line G B.

In the ſame manner muſt you proceed with the reſt of the Sides, *viz.* B C, C D, D E, E F, and you will have the ſame Figure of the Field, in all reſpects, as you had in the laſt Chapter.

CHAP. XXXIII.

How to take the Plot of a Field at divers Stations in divers Angles, where all cannot be ſeen from one, and to meaſure from your Stations to every of the reſpective Angles.

SUppoſe *Fig.* 13. to be a Field to be plotted, whoſe Angles cannot be ſeen from any one Angle thereof, wherefore imagine you are now ſtanding in the Angle A, and conſider what Angles may conveniently be

be seen, which you find to be the Angles B, C, D and E; then in those Angles cause Marks to be set up, then placing your instrument at A (with the Needle hanging over the Meridian Line) direct your Sights to B, and note the degrees cut by the Index, which let be 31; then with your Chains measure the distance A B, which let be 2 Chains; these degrees and chains you must note down in your Field-Book, as you were before taught; then direct your Sights to C, and note the degrees cut by the Index, which you will find to be 60 deg. and 20 min. and by your Chain measuring the distance A C, you will find it to contain 3 Chains and 20 Links; these note down in your Field-Book, as before; so must you do for the rest of the Angles, *viz.* D and E, then by reason that you cannot discern the Angle at F, remove your Instrument to E, and there place it in all respects as you did in A (with the Needle hanging over the Meridian Line) then direct your Sights to F, and noting the degrees cut by the Index, which let be 90 deg. with your Chain measure the distance E and F, which let be 3 Chains and 10 Links; these note in your Field-Book as you did before, only take notice that it was observed at your second Station; then direct your Sights to G, and note the deg. cut by the Index, and measure the distance with your Chain, and note them down in your Field-Book as you did before.

In this manner you must do for all the rest of the Angles, *viz.* H and I, by noting the degrees cut by the Index, and measuring the distance with your Chain, and you will find that they will stand thus fit for Protraction.

The

The Angles observed at the first Station A.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Link.*
B	31	00	2	00
C	60	20	3	20
D	90	00	2	30
E	150	30	2	50

The Angles observed at the Second Station E.

The Marks in the Angles.	*deg.*	*min.*	*Chains.*	*Link.*
F	90	00	3	10
G	141	00	2	00
H	230	00	3	50
I	270	00	4	00

Thus may you do if you have never so many Stations, in any Field, near the Angles thereof.

CHAP.

CHAP. XXXIV.

How to protract or lay down any Observat taken, according to the Work of t last Chapter.

FIrſt draw a right Line at length on your Paper, represent the Meridian-Line, as N O in *Fig.* whereon place the Center of your Protractor, l ting the Line A B thereof lie directly up the Line N O in the Diagram; then at the ſeve Angles obſerved at your firſt Station, make pri with your Protracting-pin, and through thoſe pri draw the Lines A B, A C, A D, and A E; then t off from your Scale of equal parts the length of e Line, *viz.* the length of A B being 2 Chains; wh take from your Scale, and ſet it off from A to and ſo muſt you do for all the reſt, *viz.* A C, A and A E; then draw the Lines B C, C D, and D and you have finiſhed your firſt Station's Wo Then draw a parallel to N O at the point E, and up the point (as before you did at the point A) pl the Center of your Protractor, with the Line A thereof on the laſt parallel drawn; when you have done, make a Mark with your protracting-pin agai the two upper Angles obſerved, *viz.* F and G, a draw thoſe two Lines, then turn the Arch of yo Protractor downwards, letting the Line A B of yo Protractor lie ſtill upon the Meridian of the Figu

M

M P, and then mark out the other two Angles H and I, and ſet off the length of each Line as you were taught in the laſt Station; then draw the Lines E F, F G, G H, H I, and I A, and you will find that the Figure ſo drawn ſhall repreſent the exact Figure of the Field before taken.

CHAP. XXXV.

How to take the Plot of any Field at two Stations, ſo that all the Angles may be ſeen from both Stations by meaſuring only the Stationary Diſtances by the help of the Semicircle.

SUppoſe *Fig.* 14. a Field, the Plot thereof required to be taken.

Firſt make choice of two ſuch convenient places for your Stations, as from either of them you may ſee all the Angles about the Field, and let your Stationary Diſtance be as large as you conveniently can; for the larger your Diſtance is, the better: Likewiſe take notice that your Stations muſt be ordered ſo, that neither of them be interpoſed in a right Line between the other and any Angle of the Field, but be choſen with ſuch diſcretion, as all Lines drawn from either Station to the ſeveral Angles, may interſect each other with as large Angles as may be. Let the two Points A and B in *Fig.* 14. repreſent the two Stati-

ons, from whence you may ſee all the reſt of the Angles; then having cauſed Marks to be placed in every Angle, place your Inſtrument at A (as before taught) and direct your Sights to C; obſerve the degree cut by the Index, which let be 90 deg. and the like muſt you do for all the reſt of your Angles, *viz.* D E and F, and alſo at B, your ſecond Station; then take up your Inſtrument, leaving a Mark at A, your firſt Station, and meaſure the diſtance A B with your Chain, which you will find to be 5 Chains and 26 Links; then ſet up your Inſtrument at B, your ſecond Station, letting the Needle hang over the Meridian-Line in the Chart, and direct your Sights to C, your firſt Mark (at your firſt Station obſerved) noting the degrees cut by your Index, as you have been taught in the Foregoing Chapters. So muſt you do for the reſt of the Angles, *viz.* D E and F, and they will ſtand noted in your Field-Book thus.

At the firſt Station A.

Ang.	*Deg.*	*Min.*
C	90	00
D	155	00
E	192	00
F	292	00

Your Angle to your ſecond Station B 180, and the diſtance of your Stations A and B 5 Chains, 26 Links.

At your ſecond Station **B.**

Ang.	*Deg.*	*Min.*
C	24	00
D	90	00
E	218	00
F	340	00

CHAP. XXXVI.

How to protract or lay down any Obſervation taken, according to the Work of the laſt Chapter.

FIrſt draw a Line repreſenting the Line A B in *Fig.* 14. and make it equal to 5 Chains and 26 Links, by taking it off from your Line of equal parts; then place the Center of your Protractor upon the point A, and make the Line A B thereof lie on the Line **A B** in your Diagram; then with your protracting-pin make Marks againſt every Angle obſerved on your Paper, and through each Mark draw Lines; then take off your Protractor, and place the Center thereof upon the point B, letting the Line A B of your Protractor lie on the Line A B in your Diagram, and with your protracting-pin make Marks againſt the

ſeveral Angles obſerved in your ſecond Station, and through thoſe Marks draw Lines as you did before, and where theſe Lines do interſect, the Lines drawn at your firſt Station, are the Angles of your Field; therefore at each interſection draw the Lines C D, D E, E F and F C, and you ſhall have upon your Paper the exact Symetry or Proportion of your Field.

And in this kind of plotting you will perceive a wonderful quick diſpatch; you being only to obſerve the degrees cut, and the Stationary diſtance; but in this kind of way there muſt be a great care taken in the obſerving your Angles, and the protracting of them; for by reaſon of the acuteneſs of the Angles, without exact and curious drawing of your Lines, and obſerving the preciſe points of interſection, you may run into groſs miſtakes.

CHAP. XXXVII.

How to take the Plot of a Field upon your plain Table at two Stations, taken within the ſame Field, without tedious travelling about the ſame, by meaſuring only the Stationary Diſtance.

LEt *Fig.* 14. be a Field to be plotted, and let A and B be the two Stations where you are to ſtand to take your Obſervations; then having placed your Table, with a ſheet of white Paper ſtretched thereon, make

make a mark with your Pen, repreſenting your firſt Station A, and turning your Inſtrument till you make the Needle hang over the Meridian-Line of the Chart, you muſt

1. Direct your Sights to the Angle C, and draw the Line A C.

2. Direct your Sights to D, and draw the Line A D.

3. Direct your Sights to E, and draw the Line A E.

4. Direct your Sights to F, and draw the Line A F.

This done, direct your Sights to your ſecond Station at B, and draw the Line A B; then (with your Chain) meaſure out your Stationary diſtance A B, 5 Chains 26 Links; then removing your Inſtrument to B, the Needle hanging over the Meridian-Line of the Chart, make obſervation as you did before at A, as,

1. Direct your Sights to C, and draw the Line B C.

2. Direct your Sights to D, and draw the Line B D.

3. Direct your Sights to E, and draw the Line B E.

4. Direct your Sights to F, and draw the Line B F.

Now you may plainly perceive by *Fig.* 14. where the correſpondent Lines at each Station interſect; as,

1. The Lines A C and B C interſect or croſs each other at C.

2. The Lines A D and B D interſect or croſs each other at D.

3. The Lines A E and B E interſect or croſs each other at E.

 4. The

4. The Lines AF and BF interſect or croſs each other at F.

Therefore if from the Points of Interſection you draw Lines *viz.* CD, DE, EF, and FC, you will have upon your Paper the exact proportion of your Field.

I might now proceed to ſhew you the manner of taking the Plot of any Field without approaching nigh the ſame; but in regard the performance thereof differeth nothing at all from the taking the diſtance of ſeveral places one from the other, and if you do but imagine every Angle of the Field to be a Steeple, and work as you were taught in Chapter 20. you will find it very eaſie. I need not repeat the ſame things again.

CHAP. XXXVIII.

How to take the Plot of any Field by making Obſervation at every Angle, and meaſuring only one Line, but no part of the Perimeter.

LEt *Fig.* 15. be a Field to be plotted; Firſt cauſe ſome notable Mark to be ſet up in ſome convenient place thereof, ſo that it may be ſeen from any of the Angles that are round about it, which let be F; then ſetting your Inſtrument up at the Angle A, laying your Index upon the Diameter, or no deg. direct your Sights ſo placed, to B, and there make your

your Inſtrument faſt; then direct your Index to F, noting the degrees cut by your Index, which let be 43 deg. and 15 min. and meaſure the diſtance from A to F, which is 4 Chains and 34 Links (which ſhall be all the menſuration you ſhall need to uſe in this Work) then remove your Inſtrument to B, the Index lying upon the Diameter, as before, and turn your Inſtrument about till you eſpie your firſt Station at A, there make your Inſtrument faſt, and direct your Sights to F, noting the degrees cut by the Index in your Field-Book, laying the Index upon the Diameter, as before, turn your Inſtrument about, till through the Sight you eſpie the mark in the Angle at C, there make your Inſtrument faſt, and direct your Sights to F, and you will find the degrees cut by the Index to be 61 deg. 30 min. then remove your Inſtrument to the Angle at C, and laying the Index upon the Diameter, turn the Inſtrument about till through the Sight you eſpie the mark at B; then faſten the Inſtrument there, and direct your Sights to F, noting the degrees cut by the Index, which let be 55 deg. 50 min. After this manner muſt you do for all the reſt of the Angles, noting what Angles each Angle makes, with the mark F; when you have ſo done, you will find all the Angles will ſtand thus in your Field-Book.

The length of the Line A F is 4 Chains 34 Links.

The Angles observed at the going round the Field.

			deg.	min.
The Angle	BAF	is	43	15
	ABF		68	00
	CBF		61	30
	BCF		55	50
	DCF		41	50
	CDF		95	15
	EDF		73	00
	DEF		33	00
	AEF		41	10
	EAF		34	00

And by reaſon the three Angles of a plain Triangle are equal to 180 deg. the Angles at the Centers will be as follow.

			deg.	min.
The Angle	AFB	is	68	45
	BFC		62	40
	CFD		42	55
	DFE		70	00
	EFA		106	50

Theſe Angles at the Center are very uſeful, as you may ſee when you come to Protraction.

CHAP.

CHAP. XXXIX.

How to protract or lay down any Obſervation taken according to the Work of the laſt Chapter. Fig. 15.

FIrſt draw the Line A B at pleaſure, then place the Center of your Protractor upon the point A, making the Line A B thereof lie directly on the Line A B of your Diagram; then laying your Field-Book before you, make a mark with your protracting-pin againſt the Number of the Angle B A F, which is 43 deg. 15 min. then draw the Line A F, and make it equal to 4 Chains 34 Links; then removing your Protractor to F, make the Line A B thereof lie directly on the Line F A, and with your Protracting-pin make a mark againſt the number of the Angle A F B, and draw the Line F B; then remove your Protractor to B, making the Line A B thereof lie directly on the Line B F, and with your protracting-pin make a mark againſt the Number of the Angle C B F; then remove your Protractor to F, making the Line A B thereof ly directly on the Line F B, and with your protracting-pin make a Mark againſt the Number of the Angle at the Center B F C, and draw the Line F C, and likewiſe draw the Line B C to interſect the Line F C in C; then remove your Protractor to C; letting the Line A B of the ſame ly directly on the Line C F, and with your protract-

ing-

ing-pin make a mark againſt the Number of the Angle D C F, and draw the Line C D at pleaſure; then remove your Protractor to F, letting the Line A B of the ſame lie directly on the Line F C, and with your protracting-pin make a mark againſt the Number of the Angle at the Center C F D, and draw the Line F D to interſect the Line C D in D; then remove your Protractor to D, letting the Line A B thereof lie directly on the Line D F, and with your protracting-pin make a mark againſt the Angle E D F, and draw the Line D E at pleaſure; then remove your Protractor to F, letting the Line A B thereof lie on the Line F D, and with your protracting-pin make a mark againſt the angle D F E, and draw the Line F E to interſect the Line D E in E; then remove your Protractor to E, letting the Line A B thereof lie on the Line E F, and with your protracting-pin make a mark againſt the angle E F A, and draw the Line E A to interſect the Line F A in A. Thus have you the exact proportion of your Field upon Paper,

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CHAP.

CHAP. XL.

How to take the Plot of any Field by making Obſervation at every Angle, and meaſuring only one Line, but no part of the Perimeter, by the plain Table.

SUppoſe ABCDE in *Fig.* 15. to be a Field, and it is required to take a Plot thereof.

Firſt cauſe a mark to be placed in the Field, ſo that it may be ſeen from all the angles, which let be F.

Then having your plain Table placed with a Sheet of white Paper thereon, make a mark in ſome convenient place thereof, which muſt repreſent the mark in the Field at F; then placing your Inſtrument at A, lay your Ruler with Sights upon the Table, ſo that you may diſcern the mark at F; then making your Inſtrument faſt, lay your Ruler ſo that you may ſee the mark at B, and draw the Line A B at pleaſure; then remove your Inſtrument to F, lay the Ruler on the Line A F, and turn the Table about till through the Sights you ſee the mark at A, there make your Table faſt, and lay your Ruler ſo, that through the Sights you may ſee the mark at B; then draw the Line F B to interſect the Line A B in the point B; then remove your Inſtrument to B, and laying the Ruler and Sights on the Line B F, turn your Table about until you ſee the mark at F, there make your Inſtrument faſt;

faſt; then direct your Sights to C, and there by the edge of your Ruler draw the Line B C at pleaſure; then remove your Inſtrument to F, and laying your Ruler upon the Line F B, turn your Inſtrument about until you can ſee the mark at B, there make your Inſtrument faſt; then direct your Sights unto C, and draw the Line F C to interſect the Line B C at the point C; then remove your Inſtrument unto C, and laying your Ruler with Sights on the Line C F, turn the Inſtrument about until you ſee the mark at F, there make it faſt, and direct your Sights to the mark at D, and draw the Line C D at pleaſure; then remove your Inſtrument to F, letting the Ruler with Sights lie on the Line F C, and there make it faſt; then direct your Sights to D, and draw the Line F D, to interſect the Line C D in the point D; then removing your Inſtrument unto D, letting the Ruler with Sights lie on the Line D F, and turning your Inſtrument about until you eſpie the mark at F, there make it faſt; then direct your Sights unto the mark at E, and draw the mark D E at pleaſure; then remove your Inſtrument unto E, letting your Ruler with Sights lie on the Line F D, and turn your Inſtrument about until you eſpie the mark at D, there make it faſt; then direct your Sights to E, and draw the Line F E, to interſect the Line D E at the point E; then remove your Inſtrument unto the point E, letting your Ruler with Sights lie on the Line E F, then turning your Inſtrument about until you eſpie the mark at F, there make your Inſtrument faſt, and direct your Sights unto A, your firſt Station, and draw the Line E A by the edge of your Ruler, and you have done.

Then have you the true proportion of your Field upon the Paper on the plain Table.

CHAP.

Fig: 13.

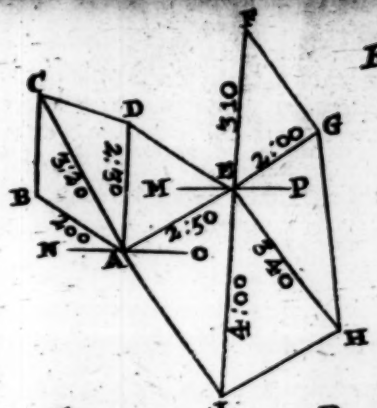


Fig: 14.

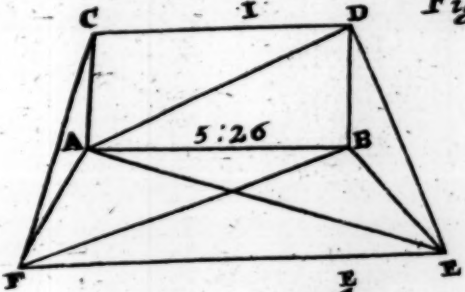
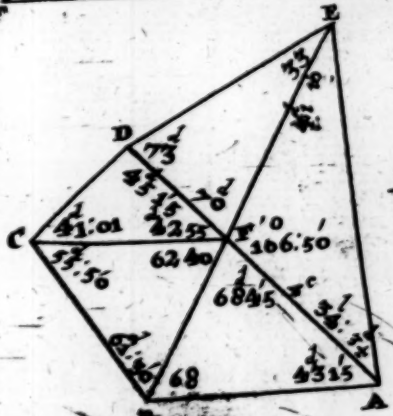


Fig: 15.



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CHAP. XLI.

How to take the Plot of a Wood or other over-grown Ground by the Semicircle, by going round the ſame, and making Obſervation at every Angle, when by reaſon of the thickneſs of the Wood or otherwiſe, you cannot (from any ſtation taken in the midſt thereof, or from any Angle) view all the reſt of the Angles. Fig. 16.

FIrſt cauſe Marks to be placed in the angles of the Field, when you have ſo done, make choice of our places for your Stations, *viz.* A B D E, and at ach place ſet a mark; then place your Inſtrument at (it being your firſt Station) letting your Index e on the Diameter, and turn it about until you eſpie he Mark at E, there make it faſt, and direct your ights to B, noting the degrees cut by the Index, hich let be 90 deg. theſe 90 deg. ſet down in the rſt and ſecond Columns of your Field-Book; then ith your Chains meaſure how far the Hedge on the ght hand is from your Inſtrument, and call that the ff-ſet to the Right, which let be A E 50 Links; hen with your Chain meaſure towards your mark at , until you come to the place C, at which place ou find the Hedge to have an angle; therefore cauſe your

your men to measure with your Chain the distance of C F, which you will find to be 1 Chain 10 Links; this 1 Chain 10 Links ought to be set down in your Field-Book in this manner, *viz.* at 2 Chains distance from A the Off-set to the Right is 1 Chain 10 Links; then measuring on to B, your second Station, you will find it to be 4 Chains, 48 Links, and the Off-set to the Right to be 50 Links, placing your Instrument at B, your second Station, letting your Index lie on the Diameter or degrees, and turning your Instrument about, until through the Sights you espie the mark that you left at your first Station, there make your Instrument fast; then direct your Sights to D your third Station, and note the degrees cut by your Index down in your Field-Book; then measure the distance of the Hedge from your second Station, which call the Off-set to the Right, because the Hedge is to the Right hand of your place of standing; then with your Chain measure the distance from B to D, which let be 4 Chains; these 4 Chains you must note down in your Field-Book, as before; then taking up your Instrument, and placing a mark in the room thereof, go to your mark at D, and measure how far the Hedge is from your third Station, which let be 1 Chain 50 Links; call this the Off-set to the Right also, noting it down in your Field-Book, as you did the rest; then placing your Instrument at D, your third Station, let your Index lie upon the Diameter of your Semicircle, and turn it about till through your Sights you espie the mark that you left at your second Station, and there make it fast; then direct your Sights to the mark at E, and note the degrees cut by the Index, down in your Field-Book; then measure the distance of the Hedge at K, from

your

your Station at D, which let be 60 Links; note this down in your Field-Book, as you did the Off-ſet to the Right before; then with your Chain meaſure the Diſtance foom D to E, which let be 4 Chains 48 Links; then (taking up your Inſtrument, and placing a mark in the room thereof) remove your Inſtrument to E, your fourth mark, letting the Index lie upon the Diameter thereof, turn it about until you can ſee the mark at D; there make it faſt, and direct your Sights to A, your firſt Station, noting the degrees cut by your Index in your Field-Book, as you did before; then meaſure the diſtance of the Hedge from the place of your Inſtrument at E, which let be 1 Chain 20 Links; note this down in your Field-book, Off-ſets to the Right, and likewiſe meaſure the diſtance of the Hedge M from your place of ſtanding, and note this down Off-ſets to the Right as before; then meaſure with your Chain the diſtance of E from A, your firſt Station, which let be 4 Chains; note this down in your Field-Book alſo; then at your firſt Station A meaſure the diſtance of the Hedge at N from the place of your Inſtrument, noting it down Off-ſets to the Right in your Field-Book. Theſe things if you have done right, will ſtand as in the following Table.

This Character ⊙ doth repreſent the Stations; the two laſt Columns are the Off-ſets to the Right hand; the Letters are the places where the Off-ſets do touch the Hedge.

deg.

		deg.	min.	C.	L.	R.C.	R.L.	
1 ⊙	A	90	00	—	—	00	50	E
	AC	—	—	2	00	1	10	F
	AB	—	—	4	48	0	50	G
2 ⊙	B	90	00	—	—	0	50	H
	BD	—	—	4	00	1	50	I
3 ⊙	D	90	00	—	—	00	60	K
	DE	—	—	—	—	1	20	L
4 ⊙	E	90	00	—	—	1	10	M
	EA	—	—	4	00	1	00	N

CHAP. XLII. *Fig.* 16.

How to protract or lay down any Observation taken, according to the Directions of the last Chapter.

FIrst draw the Line AB at pleasure, and upon the point A lay down the Center of your Protractor, with the Line thereof lying upon the Line AB that you have drawn, and mark with your protracting-pin the Quantity of the angle at the first Station, (which is noted down in the Field-Book with the Mark ⊙) 90 deg. then draw through that prick so made, the Line AE at pleasure, and look in your Table or Field-Book for the length of the Line AB,

A B, and you will find it to be 4 Chains 48 Links; theſe Chains and Links take from off your Scale of equal parts, and place it from A to B; then remove your Protractor to B, your ſecond Station, letting the Line A B thereof lie directly on the Line A B of the Figure; then look (what Angle you had when you were at B) in your Table or Field-Book marked with 2 ⊙, and you will find it to be 90 deg. then with your protracting-pin make a mark againſt 90 deg. of your Protractor, and through that point made, draw the Line B D at pleaſure; then look for the length of the Line B D in your Table, which you will find to be 4 Chains; theſe Chains take off from your Scale, and ſet them off from B to D; then remove your Protractor to D, your third Station, and letting the Line A B thereof lie upon the Line B D of the Figure, make a mark againſt the angle that was obſerved at the third Station, which is noted down in your Field-Book with the mark 3 ⊙, 90 deg. then through that mark draw the Line D E; and ſo ſhall the Line D E interſect the Line A E in the point E; and the angle at E, if you have protracted right, will be equal to the angle obſerved at the 4th. Station, and the length of the Lines D E and A E will be equal to their meaſured diſtance; then have you done with protracting your principal Lines. You muſt protract your Off-ſets thus; you ſee at your firſt Station A, the Hedge was 50 Links to the Right, repreſented in the Diagram by the Letter E; theſe 50 Links take off from your Scale of equal parts, and ſet it from A to E; then looking in your Field-Book, you will find that at 2 Chains diſtance from A towards B, the Hedge is from you 1 Chain 10 Links; theſe Chains and Links being taken from off your Scale,

ſet one Foot of your Compaſſes in C, in the Line A B, and with the other make a mark repreſenting the angle at the Hedge at F; then draw a Line from the point F through E at length, and finding your Off-ſets to the Right at the end of 4 Chains 48 Links, to be 50 Links, take 50 Links from your Scale, and ſet it off from B to G, and draw a Line from F through G at length; then finding at the beginning of your Line B D the Off-ſet to be 50 Links to the Right, ſet that off alſo as you did the other; then finding that at the end of your Line B D, *viz.* at D the Off-ſet, to be 1 Chain 50 Links, ſet that off alſo from D to I; then draw the Line I H, which Line ſo drawn, will interſect the Line F G in the point O, which is one angle of the Field; then finding that at the beginning of the Line D E the Off ſet to be 60 Links, theſe 60 Links ſet off from D to K, as you did the other before; then at the end of the ſame Line D E the Off-ſet, is 1 Chain 20 Links; take theſe Chains and Links from off your Scale, and ſet it off from E to L; then draw the Line K L, which Line will interſect the Line I H in the Point P, which is another angle of the Field; then at the beginning of the Line E A, your Off-ſet to the Right, was 1 Chain 10 Links (as you may ſee by your Field-Book or Table;) theſe Chains and Links you muſt ſet from E to M, and at the end of the ſame Line E A, you will find the Hedge to be 1 Chain to the Right; this one Chain take off from your Scale, and ſet from A to N; then draw the Line M N, which you will find to interſect the Line F E in the point R, and the Line L K in the point Q, ſo will you have the exact Figure of your Field.

☞ Note

☞ Note, you muſt take your Off-ſet as often as you find the bending or angles to be againſt you as you meaſure along your Stationary Lines, and likewiſe when you begin to meaſure your Stationary diſtance, and when you end; and by that means you have two off-ſets at every Station; as for example,

The Off-ſet A E is at the beginning of the Line A B, and the Off-ſet A N is at the end of the Line E A.

Note alſo, That the fewer Stations you make, the truer you will take the Plot of the Field; if it be be poſſible, never make above 4 Stations, and then you need not be at much trouble to make your Work cloſe.

This way of taking a Plot of a Field by going about the ſame, and taking Off-ſets, was never by any Author (that I could meet with) treated on; which is a thing I have much admir'd, it being ſo uſeful; for no man can take the Plot of a Field by going about it, except he take his Off-ſets; and for want of this very thing, though many men have underſtood an Author well, yet when they came to take the Plot of a Field by going about the ſame, they have not known which way to begin or end their Work; and to follow the direction of their Author, they muſt go upon the top of the Bank or Hedge: wherefore I have been as plain as poſſible I could to clear this Point, becauſe it is of ſo excellent uſe in drawing a Map of many Encloſures.

☞ Note alſo, To take the Plot of a Wood, is the ſame with taking the Plot of a Field by going round it; only when you take the Plot of a Field, you go about the inſide thereof, and when you take the Plot of a Wood, you go about the outſide; but the manner of taking the Off-ſets are the ſame in

both. Be ſure you let your Stationary diſtance be as large as you can, and you cannot fail of having your deſire.

CHAP. XLIII.

How to know whether you have truly wrought and whether your Plot will cloſe or no, when you make Obſervations at ſeveral Stations in going about a Field.

YOu muſt collect the Quantity of all the angles found at your ſeveral Obſervations into one ſum, then multiply 180 deg. by a Number leſs by two than the Number of angles that you obſerved, and if the Product of this Multiplication be equal to the total Sum of all your angles obſerved, then have you wrought right, otherwiſe not.

Example.

Thus the angles found in the laſt Chapter, were as followeth; the Sum of them being 360 deg. Now becauſe you had but 4 Stations, you muſt multiply 180 deg. by 2 (which is a Number leſs by two than the Number of Stations in the Field) and the Product will be 360, which exactly agreeth with the Sum of all the angles obſerved at your four Stations.

180

			deg.	min.
180		A	90	00
Multiplied by 2	The Angle	B	90	00
Product 360.		D	90	00
		E	90	00
	The Sum		360	00

CHAP. XLV.

How to take the Plot of any Field by the help of the Chain only.

LEt *Fig.* 17 be a Field, and it is required to take a Plot thereof without making uſe of any Inſtrument except *Gunter*'s Chain.

Firſt, Beginning your Work at A, meaſure the length of the Side A B, which let be 2 Chains 17 Links; theſe 2 Chains and 17 Links note down in your Field-Book; then beginning at B, meaſure the diſtance of B from C, which let be 2 Chains 4 Links; note this down in your Field-Book alſo; then beginning at C, meaſure croſs from C to A, in as direct a Line as you can, which let be 2 Chains 76 Links; note this down alſo in your Field-Book; then beginning again at A, meaſure the diſtance from A to E, which let be 1 Chain 76 Links; note this down alſo in your Field-Book as before; then being at E, meaſure the diſtance of E from D, which let be 1 Chain 75 Links; note this down as before; then being at D, meaſure croſs from D to A, which let be 2 Chains 75 Links;

note this down alſo; then come back again to D, and meaſure the diſtance from D to C, which let be 1 Chain 99 Links; note this down in your Field-Book alſo; then have you reduced this Field in 3 Triangles, and you have the length of every ſide of each Triangle; and when you have noted them down in your Field-Book, they will ſtand thus.

The Length of each Side in Chains and Links.

		Chains,	*Links.*
In the firſt Triangle	A B	2	17
	B C	2	4
	C A	2	76
In the ſecond Triangle	A E	1	76
	E D	1	75
	D A	2	75
In the third Triangle	A D	2	75
	A C	2	76
	D C	1	99

CHAP.

CHAP. XLVI. Fig. 17.

How to protract or lay down any Obſervation taken, according to the Work of the laſt Chapter.

FIrſt draw a Line at pleaſure, and take off 2 Chains 17 Links from off your Scale of equal parts, it being the length of the Line A B, and place it from A to B; then take off the length of the Side B C, *viz.* 2 Chains 4 Links, and ſetting one foot of your Compaſſes in the point B, with the other deſcribe a ſmall Arch; then take off the length of the Line A C, *viz.* 2 Chains 76 Links, and ſetting one foot of your Compaſſes in A, with the other interſect the ſmall Arch in C, and draw the Line A C and C B, and then have you done with the firſt Triangle; then the next Triangle that you muſt begin with will be the third Triangle; thus take off the length of the Side C D (in the third Triangle, which is 1 Chain 99 Links) from your Scale of equal parts, and ſetting one foot of your Compaſſes in the point C, with the other deſcribe a ſmall Arch, then take the length of the Line A D from off your Scale of equal parts, and ſetting one foot of your Compaſſes in A, with the other interſect the ſmall Arch before deſcribed, and from that interſection draw the Lines C D and A D, and ſo have you done with the third Triangle; then for the ſecond Triangle, take off the length of the

Line DE from your Scale of equal parts, and ſetting one foot of your Compaſſes in the point D, with the other deſcribe a ſmall Arch; then take the length of the ſide A E from off your Scale of equal parts alſo; and ſetting one foot of your Compaſſes in the Point A, and with the other interſect the ſmall Arch, and from that Interſection draw the Lines A E and D E, and thus you have done with all the angles that you meaſured, & you ſhall find (if you have wrought right) the exact figure of your Field upon your Paper. Note that this way is as exact a way as can be performed for ſmall Incloſures, but it is very troubleſom; but if it ſhould happen that a man be deſtitute of other Inſtruments, he may make uſe of this way of Plotting a Field.

Note alſo, That as you meaſure by the Hedge-ſide, you muſt make a ſmall allowance (for by reaſon of Brambles and Briars you cannot go cloſe by the Bank) to the length meaſured.

Obſerve likewiſe that when any Encloſure is hilly and daly, you cannot lay the true Plot down this way; but in level ground, and when there is no great matter of Riſe or Fall, you may.

CHAP.

CHAP. XLVII.

How to find the Area or superficial Content of any plain Figure, and to reduce irregular Figures into regular Forms, and to find the Content thereof.

HAving shewed how to draw the Plot of any Field or other Inclosure upon Paper, it is now necessary to shew how the Content thereof may be attained; that is to say, how many Acres, Roods and Pershs any Field so plotted doth contain; for the performance whereof you must consider that one Statute-Pole or Perch doth contain 16 foot and an half. 40 of those Poles in length, and 4 in breadth do make an Acre; so there are contained in an Acre 160 square Pole, and in a Rood 40 square Pole, it being the 4th. part of an Acre; you must likewise consider that the original of the mensuration of all superficial Figures, such as Land, Board, Glass, or the like, do depend upon the exact measuring of certain Regular Figures, as the Geometrical Square, the long Square, the Triangle, the Circle, and the Trapezium; so that any Plot of Land to be measured, if it be not in the form of one of these Figures, it must (before it be measured) be reduced into one of them. I will therefore in the first place shew you how to measure any of the said Figures severally by themselves,

and

and then how you ſhall reduce any other Figure (how irregular ſoever it be) into ſome of theſe Forms, and then how to meaſure it by the ſame Rules: And firſt,

Of a Geometrical Square.

A Geometrical Square doth conſiſt of 4 equal ſides and angles; and to meaſure it, or find the ſuperficial content thereof, you muſt multiply any one of the ſides in it ſelf, and the Product of that Multiplication ſhall be the Content of the Square.

Example.

Let there be a ſquare piece of Land, and the ſide thereof to contain 8 poles in length; this 8 being multiplied in it ſelf (that is 8 by 8) the product will be 64, and ſo many ſquare pole is there in this ſquare piece of Land.

Of a long Square.

A long Square is a Figure conſiſting of four ſides, whereof the two longer ſides are equal, and the two ſhorter are likewiſe equal; it doth in all reſpects repreſent a Deal Board; and to find the ſuperficial Content of any ſuch long Square is thus, Multiply one of the longer ſides by one of the ſhorter, and the product of that Multiplication ſhall be the *Area* or Content thereof.

Of the Triangle.

Though there be ſeveral kinds of *Triangles*, yet in reſpect

reſpect they are all meaſured by one and the ſame Rule, I will therefore add but one Example for all, which take for a general Rule.

In all right-lined *Triangles* whatſoever, half the length of the Baſe being multiplied by the length of the Perpendicular, ſhall be equal to the *Area* or content of the *Triangle*.

Or,

Half the length of the Perpendicular being multiplied in the length of the whole Baſe, ſhall be the content of the *Triangle*.

Or again,

If you multiply the whole Perpendicular by the whole Baſe, half the product ſhall be the content of the *Triangle*.

Example.

Suppoſe you were to find the *Area* or content of the *Triangle* S R Q. Firſt, from the Angle R, you muſt let fall the Perpendicular R E, let the length thereof be 24 Perches, and the length of the Baſe 44 Perches. *Fig.* 18.

Now if you multiply 12 (which is half the length of the Perpendicular) by 44 (the length of the whole Baſe) the product will be 528, and that is the *Area* or Content of the *Triangle*.

Or,

If you multiply 24 (the whole length of the Perpendicular) by 22 (the length of half the Baſe) the product will be 528 as before.

Or

Or again,

If you multiply 44 (the whole length of the Base) by 24 (the whole length of the Perpendicular) the product will be 1056, the half whereof will be 528, the *Area* or Content of the *Triangle*, as before.

Of a Trapezium.

A *Trapezium* is a Figure consisting of four unequal Sides, and as many unequal Angles, as is the Figure A C B D.

To measure this *Trapezium*, you must first reduce it into two *Triangles*, by drawing the Diagonal Line A B; for by this means your Figure is reduced into two *Triangles*, namely, the *Triangles* A C B and A D B; then if you let fall the Perpendiculars from the points D and C, you measure them by the last Examples, as if they were two *Triangles*, the sum whereof being added together, will be the *Area* or content of the whole *Trapezium*.

Example. Fig. 19.

Having drawn the Line A B, and so reduced the Figure into two Triangles, and let fall the Perpendiculars from C and D (the Base A B being common to both Triangles) suppose the Perpendicular at C were 20 Perches, the Perpendicular at D 10 Perches, and the Base A B (serving for both Triangles) 42 Perches,

If

If now according to your former Directions you multiply 42 the Baſe, by 10, half the Perpendicular, the product will be 420 for the content of the Triangle A C B.

In like manner, if you multiply 42, the Baſe, by 5, half the other Perpendicular, the product will be 210 for the content of the Triangle A D B.

Now if you add the Contents of theſe two Triangles together, namely 420 and 210, the ſum of them is 630, and that is the content of the whole *Trapezium* A C B D.

But this Work may be performed with more brevity, thus;

In regard the Baſe A B is common to both the Triangles, you need therefore do no more but add the two Perpendiculars together, the half whereof being multiplied by the whole Baſe, the product ſhall be the content of the whole *Trapezium.*

Example.

The two Perpendiculars 10 and 20 being added together, the ſum of them is 30, the half whereof is 15; this Number being multiplied by 42, the whole length of the common Baſe, giveth 630, the content of the whole *Trapezium.*

Or,

You may multiply the ſum of the Perpendiculars by the length of the Baſe, and half the product ſhall be the content.

Of

Of the reducing irregular Figures into Trapezium and Triangles, and to caſt up the Contents thereof.

Let A B C D E F G be the Figure of a Field drawn upon your plain Table, or otherwiſe protracted upon Paper, according to any of the former Directions.

In regard that the field is irregular, that is to ſay, it is neither a Circle, Triangle, Square or Trapezium, it muſt therefore (before it be meaſured) be reduced into ſome of theſe forms, which to perform, do thus, draw Lines to every other Angle, as the Lines G B, B D, D F and F B, then will the whole Figure be reduced into 5 Triangles.

As,

1. The Triangle G A B.
2. The Triangle B C D.
3. The Triangle D E F.
4. The Triangle F B G.
5. The Triangle F B D.

Fig. 20.

Theſe five Triangles muſt be all meaſured ſeverally, according to the Directions before given, and then the contents of all the five Triangles being added together in one ſum, that ſum ſhall be the *Area* or content of the whole Field.

As ſuppoſe the Triangle G A B ſhould contain 53 Perches, the Triangle B C D 47 Perches, the Triangle D E F 39 Perches, the Triangle G B F 74 Perches, and the Triangle B F D 68 Perches.

Theſe five Numbers being added together, make 281

281 Perches, and that is the Area or content of the whole Field in Perches.

But for an abbreviation of this Work, you need not find the Area of every Triangle, but of every Trapezium; for the Figure is as well divided into Trapeziums as Triangles; as namely the Trapeziums A B F G and B C D F, and the Triangle D E F, ſo that by this means you need but to find the Area or content of theſe two Trapeziums, and one Triangle, which will abbreviate nigh half of the Arithmetical Work; for if you meaſure the two Trapeziums, as hath been ſhewn in this Chapter, you ſhall find the Trapezium G A B F to contain 127 Perches, and the Trapezium B C D F to contain 115 Perches, and the Triangle D E F to contain 39 Perches, which three Numbers being added together, produce 281, exactly agreeing with the former.

Here note that at any time when you reduce any irregular Plot into Triangles, your Number of Angles will be leſs by two than the Number of the Sides of your Plot, as in this the Plot conſiſted of 7 ſides, and you ſee it is reduced into 5 Triangles.

Of the Circle.

The Proportion of the Circumference of any Circle to his Diameter is as 7 to 22 (or in larger terms, as 10000 to 31416.

Now to find the Area or content of any Circle, you muſt multiply the Diameter thereof in it ſelf, and multiply that Sum by 11, which product being divided by 14, ſhall give you the Area of the Circle.

Or,

Or,

Multiply the Semi-diameter and the Semicircumference, and the product ſhall be the Area of the Circle.

*Example. Fig.*21.

In the Circle DFGE; let the Diameter thereof DE be 28, which multiplied in it ſelf, giveth 784; this Number being multiplied by 11, giveth 8624, which being divided by 14, the Quotient will be 616, and that is the Area of the Circle.

The Circumference of a Circle being given to find the Diameter.

Multiply the Circumference by 7, and divide the product by 22, the Quotient ſhall be the length of the Diameter.

Example.

Let the Circumference of the Circle DEFG, be 88, this multiplied by 7, giveth 616, which being divided by 22, giveth 28 for the length of the Diameter.

CHAP.

CHAP. XLVIII.

Containing certain Arithmetical and Geometrical Propoſitions for the ſeparation and diviſion of Land.

PROP. 1. *Fig.* 22.

A Right Line being given, to divide the ſame, according to any Proportion aſſigned.

SUppoſe A be a Line given, and let it be required to divide the ſame into two parts bearing proportion the one to the other, as the Line B doth to the Line C.

Firſt draw the Line F D equal to the given Line A, then draw the Line E D (to contain any Angle at pleaſure) and from D to H place the Line C, and from H to E place the Line B.

Then draw the Line E F, and laſtly, draw the Line H G parallel to the Line E F, which ſhall cut the Line F D in the point G, ſo is the Line F D (which is equal to the given Line A) divided in the point G, in proportion as the Line B is to the Line C.

PROP. 2. *Fig.* 22.

To perform the same Arithmetically.

Let the Line A be 72, and let the Line B be 50, and the Line C 40, according to which proportion, let it be required to divide the Line A.

First, Say by rule of proportion, if 90 (which is the sum of the two proportional terms) give 72 (the whole given Line) what shall 50 (the greater part) give? Multiply and divide, and you shall have in the Quotient 40, for the greater part of the Line A, which being substracted from 72 the whole Line, there will remain 32 for the lesser part.

PROP. 3. *Fig.* 23.

How to divide a Triangle into two parts, according to any Proportion assigned, by a Line drawn from any Angle thereof.

Let A B C be a Triangle given, and let it be required to divide the same; by a Line drawn from the Angle A, into two parts, the one bearing proportion to the other, as the Line F doth to the Line G.

By either of the two last Propositions, divide the Base of the Triangle B C in the point D, in proportion as the Line F is to the Line G; then draw the Line A D, which shall divide the Triangle according to the given proportion.

PROP.

PROP. 4. *Fig.* 23.

The Baſe of the Triangle being known, to perform the former Propoſition by Arithmetick.

Suppoſe the Baſe BC be 40, and let the proportion into which the Triangle is to be divided, be as 2 to 3.

Firſt, Add the two proportional terms together, 2 and 3, which makes 5; then ſay by the Rule of proportion, if 5 (the ſum of the proportional terms) give 40 (the whole Baſe) what ſhall 3 (the greater term) give? Multiply and divide, and the Quotient will give you 24, for the greater Segment of the Baſe D C, which being deducted from the whole Baſe 40, there will remain 16, for the leſſer Segment B D.

PROP. 5. *Fig.* 23.

To divide a Triangle, whoſe Area *or Content is known, into two parts by a Line drawn from an Angle aſſigned, according to any Proportion required.*

Let the Triangle A B C contain 8 Acres, and let it be required to divide the ſame into two parts by a Line drawn from the Angle A, the one to contain 5 Acres, and the other 3 Acres.

Firſt, You muſt meaſure the whole length of the Baſe, which ſuppoſe 40, then ſay, if 8 Acres (the quantity of the whole Triangle) give 40 (the whole Baſe) what parts of the Baſe ſhall 5 Acres give?

Multiply and divide, the Quotient will be 25 for the greater Segment of the Baſe D C, which being deducted from 40 the whole Baſe, there will remain 15, for the leſſer Segment of the Baſe B D, then draw the Line A D, which ſhall divide the Triangle A B C into the given proportion.

PROP. 6. *Fig.* 24.

To divide a Triangle given into two parts, according to any Proportion aſſigned, by a Line drawn from a Point limited in any of the Sides thereof.

Let the Triangle given be A B C, and let it be required from the Point E to draw a Line that ſhall divide the Triangle into two parts, bearing proportion one to the other, as the Line I doth to the Line K.

Firſt, From the limited point E, draw a Line to the oppoſite Angle A; then divide the Baſe B C, in proportion as I to K, which point of Diviſion will be at D; then draw D F parallel to A E. Laſtly, from F draw the Line F E, which ſhall divide the Triangle as I to K.

PROP. 7. *Fig.* 24.

To perform the ſame Arithmetically.

Let it be required to divide the Triangle A B C from the point E into two parts in proportion, as 5 to 2.

Firſt,

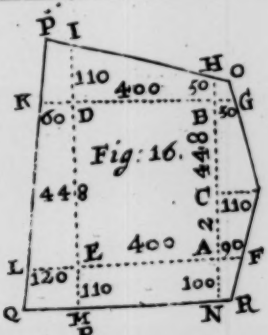
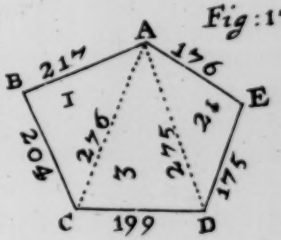


Fig: 16.



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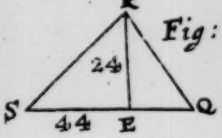

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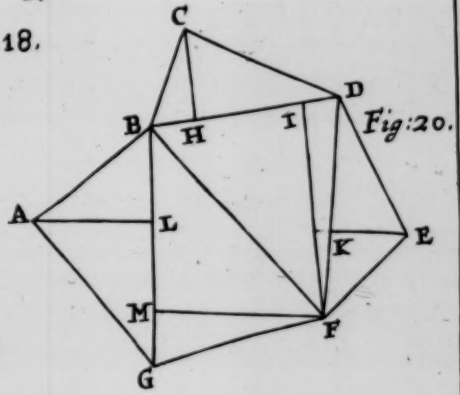

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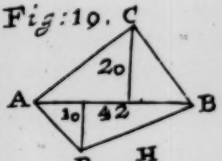

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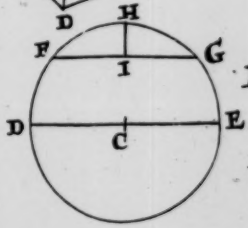

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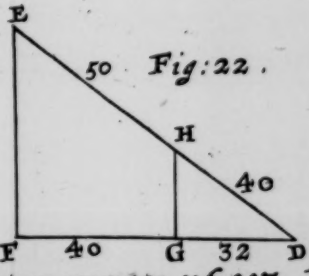

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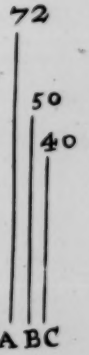

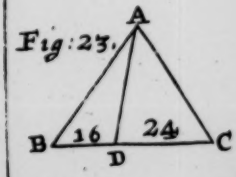

Fig: 23.

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Firſt, Divide the Baſe B C according to the given proportion, then (becauſe the leſſer part is to be laid towards B) meaſure the diſtance from E to B, which admit 30, then ſay by the Rule of proportion, if E B 30, give D B 12, what ſhall A G 40 (the perpendicular of the Triangle) give? Multiply and divide, the Quotient will be 16, at which diſtance draw a parallel Line to B C, namely F; then frnm F draw the Line F E, which ſhall divide your Triangle according to the required proportion.

PROP. 8. *Fig.* 24.

To divide a Triangle, whoſe Area or Content is known, into two parts, from a Point limited in any ſide thereof, according to any Number of Acres, Roods or Perches.

Let the Triangle A B C, whoſe quantity is 5 Acres and 1 Rood, be given, let the limited Point be E in the Baſe, and let it be required from E to divide the Triangle into two parts between M and N, namely to M 3 Acres, 3 Roods thereof; and to N 1 Acre, 2 Roods.

Firſt, Reduce the quantity of N (being the leſs) into Perches, which makes 240, then (conſidering on which ſide of the limited point this part is to be laid, as towards B) meaſure that part of the Baſe from E to B 30 Perches, whereof take half, which is 15, and thereby divide 240, the parts of N, the Quotient will be 16, the length of the Perpendicular F H, at which parallel diſtance from the Baſe B C, cut the ſide A B in F; from whence draw the Line

F E, which ſhall include the Triangle F B E, containing 1 Acre, 2 Roods, and the Trapezium A F E C contains the reſidue, 3 Acres, 3 Roods.

PROP. 9. *Fig.*25.

To divide a given Triangle by a parallel Line to one of the Sides, according to any Proportion given.

Let *Fig.*25 be a Triangle A B C be given, and let it be required to divide the ſame into two parts by a Line drawn parallel to the Line A C, and in proportion as the Line I to the Line K.

By the firſt Propoſition of this Chapter, divide the Line B C in E, as I to K; then find the mean proportion between B E and B C, which let be B F; from which point draw the Line F H, parallel to A C, which Line ſhall divide the Triangle into two parts, the Trapezium A H F C having ſmall proportion to the Triangle H B F, as I to K.

PROP. 10. *Fig.* 25.

To perform the ſame Arithmetically.

Let the Triangle be A B C, and let it be required to divide the ſame by a parallel Line to one of the ſides into two parts, to be in proportion as 4 to 5.

Firſt, Let the Baſe B C 54 be divided according to the proportion given, ſo ſhall the leſſer Segment be B E 24, and the greater E C 30; then find out a mean proportional between B E 24, and the whole

aſe

Base B C 54, by multiplying 54 by 24; whose product will be 1296, the square Root whereof is 36, the mean proportional sought, which is B F; then by the Rule of proportion say, if B F 36 give B E 24, what A D 48? The Answer is, H G 32, at which distance draw a parallel line to the Base, to cut the Side A B in H; from whence draw the Line H F parallel to A C, which shall divide the Triangle as was required.

PROP. 11. *Fig.* 25.

To divide a Triangle of any known Quantity into two parts, by a parallel Line to one of the Sides, according to any number of Acres, Roods, and Perches.

Let the Triangle be A B C, whose Quantity is Acres 8, Roods 0, Perches 16; and let it be required to divide the same into two parts, as 4 Acres, 2 Roods, 16 Perches, and 3 Acres, 2 Roods, 16 Perches, by a Line parallel to the Side A C.

First, Reduce both Quantities into Perches (as is hereafter taught) and they will be 720 and 576; then reduce both those Numbers by abbreviation, and they will be $\frac{4}{3}$, and according to that proportion divide the Base B C 54, as is before taught, which will be in E; then seek the mean proportional between B E and B C, which is B F 36, of which 36 take half and divide 576, the lesser quantity of Perches, and the Quotient will be H G 32, at which distance parallel to the Base, cut the Line A B in H; from whence draw H F, parallel to the Side A C,

which shall divide the Triangle given into two parts, according as it was required.

PROP. 12. *Fig. 26.*

There is an irregular Quadrangle, as A B C D, *which is required to be divided into two parts, from the Point* E; *as* 20 *to* 11, *so that* F E D C *and* A B E F *be to each other in quantity according to that Proportion.*

Draw the Line B G parallel to A E, and extend D A to G, then is A E G equal to E A B; because they stand both upon one Base, draw C H parallel to D E, and extend A B to H, then is the Triangle D E H equal to the Triangle E D C, and the whole Triangle G H E is equal to the whole Plot A B C D, draw a Line from G at pleasure, that may represent the number of both the proportions, *viz.* 31, which is G L M; draw M H, from G to L is 11, and L M 20; draw L F parallel to M H. Lastly, draw the Line F E, which shall divide the given Quadrangle A B C D, according to the proportion required.

PROP.

PROP. 13. *Fig.* 27.

There is a Piece of Land, as ABDC, *the Angles at* B *and* C *are Right Angles*, AB *and* DC *are parallel, and* AB 24, BC 16, DC 36; *this Piece is to be divided into two equal parts, with a Line from the midst of the Line* AD, *as* FE, *the Question is how much is* EC *and* EB?

Add AB 24, to CD 36, and it makes 60. Then say, as 60 to BC 16, so AB 24, to EC 6:4; and so DC 36, to EB 9:6, as required.

PROP. 14. *Fig.* 23.

There is an irregular Plot, as ABCD, *as in the* 23d *Figure, which is* (*Geometrically*) *required to be divided into two equal parts, in such sort that the Line of partition* KLM, *be parallel to* ADC, *and that* LP *be equal to* LQ, *and also that* BKLM, *and* ADCMLK, *be equal in quantity; the Question is, How much is* AK *and* CM?

First, draw the Line ED, so that it divide the Angle at D, into two equal parts; then draw the Line EF parallel to AB; from E, the point of intersection of DE and CB, divide AF into two such parts, as that the one part GA, be to the other part GF, as

as DC is to F D; then prolong the Line DC to I so that CI be equal to A G; then is the Quadrangle GHID of like proportion to FECD: Then make the half of the given Quadrangle ABCD, into a right-angled Square, and also GHID into a Square, the Side of the Square GHID is HS; and if we now from the Quadrangle GHID, substract the said Square of half the Quadrangle given ABCD, there shall remain a Square, whose side shall be HR; draw IS and NR parallel, then is HI to HN, as HS is to HR; and draw NL parallel to DI, and LK to DA, then is the Quadrangle OLNH equal to the Square of HR, because the Quadrangle GHID is equal to the Square HS, and also the Square of HS is so much greater than the Square of HR, equal to the half of the given Quadrangle ABCD; then is also the Quadrangle GHID so much greater than OLNH, like the half of the given Quadrangle ABCD; then is also the Quadrangle GHID so much greater than OLNM, equal to the half of the Quadrangle ABCD; and because the Line ED doth divide the Angle D equally, LP is equal to LQ; also in regard that CI is equal to AG, CINM and AGOK are equal, and because they stand between two parallel Lines, and the part KADCML, is like to OGDINI, and consequently half the given Quadrangle ABCD, and BKLM, the other half, divided by KLM, so that LP is equal to LQ, unto which AK and CM are also equal, as was required.

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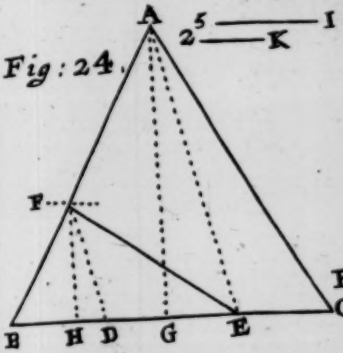

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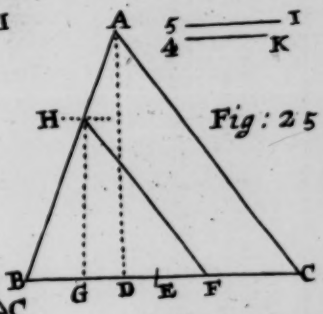

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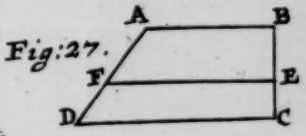

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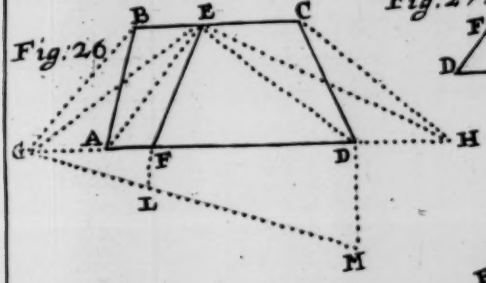

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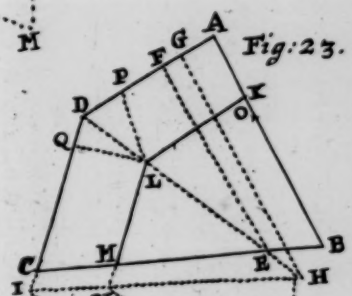

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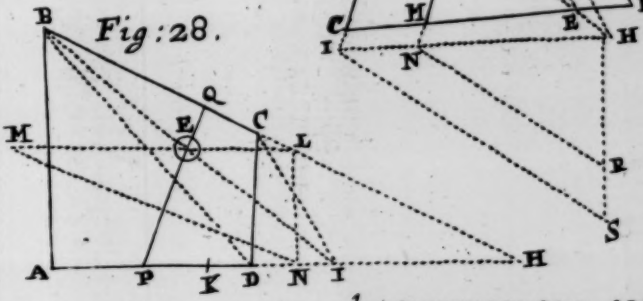

Fig: 28.

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PROP. 15. *Fig.* 28.

There is a Plot, as BACD, *which is to be divided into two parts from a Point within, as* O, *ſo that the part towards* BA, *be to the part towards* CD, *as* 10 *to* 7, *the Line of Partition in the Example is* QOP. *The Queſtion is, how this may be done Geometrically?*

Firſt, Increaſe AD, BC, till they meet in H; then draw the Line BD, and draw IC parallel to BD; then draw BI; then is BA, BI, AI, a Triangle equal to BCAD; divide AI, ſo that AK be 10, and KI 7; then by the Point O, draw ML, parallel to AD; from L, let fall a Perpendicular to AH, *viz.* LN; from N, draw MN, parallel to BH; then take the Square of EL from the Square of EM, and ſet it from N to P; then draw the Line QEP, which ſhall divide the Plot, as required.

PROP. 16. *Fig.* 29.

To divide an irregular Plot, as BCDEFAB, *into two parts, with a Line paſſing by a Point within, as* OG, *ſo that the part* CDEFVOW *be to* BWOVAB, *as* 10 *unto* 8. *The Queſtion is, how this may be done Geometrically?*

Conſidering that the Line of Partition muſt paſs through CB and AF, therefore increaſe them till they

they meet in K; draw C A and B L parallel thereto, then draw C L, draw C F, and D M parallel to C F; then draw C E M, ſo the Triangle C M L C is equal unto the whole Plot; divide the Baſe of this Triangle L M, ſo that M N may be to N L as 10 to 8; draw Q ⊙ P parallel to K M, from Q let fall a Perpendicular upon K M, *viz.* Q O; then ſubſtract the Square of Q G from the Square of G P, and the remainer ſet from O to V; then draw the Line V ⊙ W, which ſhall divide the Plot, as required.

PROP. 17. *Fig.* 30.

A Piece of Land in the form of a Triangle being given, to divide the ſame into three equal parts with Lines parallel to one of the Sides.

Let the Triangle be A B C, and let it be required to divide the ſame into three equal parts, with Lines parallel unto the Side A B.

Firſt, Divide the ſide (next to that ſide you would divide it from, *viz.*) A C, into three equal parts, (or into as many parts as is required to divide the Triangle into) and ſet two of thoſe parts upon the prolonged ſide B C, *viz.* C D and C H; then draw the two Semicircles B D and B H, and from the interſection of theſe Semicircles, with the Line A C, draw the two Semicircles K G and F I, and then draw the Lines K G and F I, which ſhall divide the Triangle into three equal parts parallel unto the Line A B, as was required.

PROP.

PROP. 18. *Fig.* 31.

Two Brethren have a Piece of Land, as ABCD, *whereof* BA *is* 24, *and* CD 36, *parallel thereto, the Angle at* C *is a right Angle,* BC *is* 16, *and* AD *is* 20.

This Piece of Land muſt be divided into two equal parts with a Line from the middle between B and C, viz. at E. The Queſtion is, what breadth each part muſt have at the other end, to make the parts equal?

Add AB 24, and DC 36 together, which makes 60; then as 60 to AD 20, ſo BA 24, to DF 8. Or as 60 to 20, ſo 36 to FA 12; and ſo muſt the Side AD 20, be divided, *viz.* AF 12, and FD 8, to make the parts equal, as was required.

PROP. 19. *Fig.* 32.

There is a Piece of Land, as ABCD, *rect-angled at* B; AB *is meaſured* 10, BC 32, DC 25, *and* AD 13. *It is required to divide this Land into two equal parts by a Line parallel to the Line* DC. *The Queſtion is, How much ſhall* ED *and* FC *be?*

Firſt, Seek how much the Perpendiculars DG, and AH are, and alſo DH, you will find DG 15, DH 5, and AH 12; then as HD 5, to AH 12, ſo DG 15, unto KG 36: Having theſe Lines, you may

may ſeek the Area of the whole Piece of Lan
which is 300, the half whereof 150; the content
the Triangle KDC is 420, from whence take 15
and there remains 270, the Area of the Trian
KEF: Then ſay, if 420 give the Square of K
3136, 270 will give 2017, for the Square of K
whoſe Root is 44 9, which ſubſtracted from 56, t
Root of the Square of KC, there reſts 11. 1; ſ
FC; in like manner ſeek ED, which you ſhall find
32, as was required.

PROP. 20. *Fig.* 33.

*There is a Triangular Piece of Land, as, AB
of unequal Sides and Angles; it is required
be divided into two equal parts by a Line
Ditch, paſſing by a Point within the ſame,
D. The Queſtion is, how this may be do
Geometrically?*

Draw firſt a Line through the Point D, paral
to the Side BA, viz. FLDE, which makes the Quadra
gle HAEF, equal to the Triangle ABG; divi
this Quadrangle into two equal parts by the Li
LMK. Now ſeeing the Triangles IKM, ML
and DEN are all of like proportion (as may appe
by their Angles) therefore from the Square of D
ſubſtract the Square of DE, and there will rem
the Square of IK; the length of the Line IK bei
known, you may draw the Line NDI, which ſh
divide the Triangular piece of Land into two equ
parts, paſſing by the point D as required.

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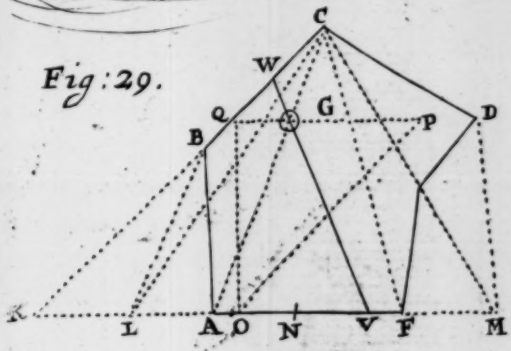
Fig: 29.



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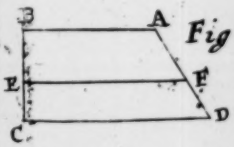

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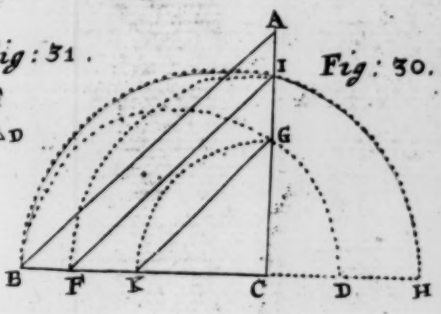

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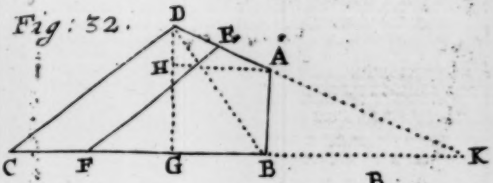

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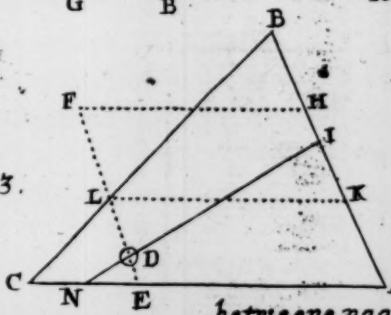

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PROP. 21. *Fig.* 34.

Here is an irregular Piece of Land formed, as A B C D, belonging unto two men, who are desirous to have the same divided into two equal parts, and to have the Line of Division pass through a Pond or Lake in the same, viz. *E, that both may have the Benefit of the Water.*

Extend the Sides A D and C B, until they meet nd make a Triangle; the Triangle made by the Line E F, divide into two equal parts with the Line A G, raw the Line H M by E, and parallel to L B, and ake the Quadrangle H M N L, equal to the Trian- le A G L, in such sort that M N be parallel to H L; en draw the Line T S through the given point E, that the Triangles E H T and S K N be together qual to E M K alone; then is the Triangle S L T qual to the Quadrangle M H L N, and equal to the riangle A G L; wherefore if we take away from he Triangle T S L, the Triangle D C L, then is S C D the one half of the Quadrangle A B C D, nd T S B A the other half, the thing required.

PROP.

PROP 22. *Fig.* 35.

There is a Rect-angled Piece of Land, as ABCD whose length is 16, *and breadth* 10, *about which it is required to make a Fish-Pond or Moat, to be in quantity* 120, *as DAB, GFED (in the Example) BA and AD are to be parallel unto GF and FE. The Question is, how much shall DE or BG be?*

Extend DC so much longer than your Plot, as AD, then is DH equal to DA and AB added together, *viz.* 26. Let EK be equal to ED, then is the Parallelogram EHIK, equal to the Fish-pond EDABGFE and 120. Now divide DIHN into two equal parts, by the Line LM; then is LD or LH 13; make KNPQ equal to LHIM, and then is the Gnomon QPNMLDEKQ also 120; and seeing that QK is equal to LH, *viz.* 13, add the Square thereof 169 to 120, the content of the Gnomon, and it makes 289, for ELOQ; whose Root is 17, for EQ, the side of the Square; from hence substract 13, being KQ, and there will remain 4, for EK; and so much is ED and BG, the thing required.

PROP.

PROP. 23. *Fig.* 36.

There is a right angled Piece of Land, as A B C D, whose length is 16, *and breadth* 12; *this piece is to be divided into two equal parts with Lines equally distant from C B and B A, as G F and F E, the Quadrangle G F E D being for a Garden, and C B A E F G C for a Cops or Wood to environ two sides thereof. The Question is how much must be A E and C G?*

Draw the Square A B K L, whose sides are 12, then will K C and L D be each 4; take half K L D C, which is I H D C, and joyn it to A L, then is A L N M equal to half G K L D, then there wanteth of the Square B I O M the little square L H O N; then let us take it that the Quadrangle E F G D is half the content of A B C D, *viz.* 96. There is taken from E F G D the part G D H Q, and that joyned to E L and E L N R, is equal thereto, so that R E F Q H L N R is yet equal in content to E F G D 96. Now add the Square L H O N whose Side L H is 2, makes 4) unto 96, and it makes 100, whose Root is 10 for the side R O, to this 10 add 2, and there is 12; for E D, also take L H 2 from E H, and rests E L 8, which is equal to E F or D G; the length of E D and F G is found 12, which multiplied, gives the Content 96, being half 192, the whole Piece, as required.

PROP. 24 *Fig.* 37.

There is an irregular Plot, as A B C D, to be divided in two equal parts with Lines equally parallel to C B and A B; D and C are right Angles, A D is measured 38, *D C* 16, *C B* 50, *and A B* 20.

Make A H equal to A B, draw B H Q, ſo that the Angle at B be equally divided, then is D H 18, and H A 20, H D muſt be ſo divided, that H M be to M D as B L to B A, I C being equal to D H, *viz.* 18, I F will be 32; then as 32 to 20, ſo 18 to 11. 25 for M H, which ſubſtracted from 18, leaveth 6. 75 for D M, draw the parallelogram A O P H, which is equal to N M D C, becauſe T H is equal to H I, and H P equal to M D; and becauſe that the Triangle H T B and H L B are equal angled, and becauſe T H P V ſtandeth between two parallel lines, *viz.* A V P H, therefore is A O P H, T H P V and N M D C equal; then is O B N M H P O A equal to the whole Plot A B C D, *viz.* 704. Multiply 26 (being half L B and H A added together) by 16, and the product 416 is the content of A B L H; then ſay as 20 to 16, ſo 6. 75 to 5. 4; for Q M, Q N is 21. 4, as C B 50, to D A 38, ſo M H 11. 25, to 8. 37, half theſe added together, multiplied by Q M 5. 4, *viz.* 9. 81, gives the content of Q P M H 52. 974, which added to 704, makes 756: 974 for the content of O B N Q, from hence take half the content of the plot 352, and there remains 404. 974 for R F Z Q, Q N multiplied in it ſelf makes 457. 96. Then if 756.

974

974 give 457.96, what will 404. 974 give? Anſwer, 243. 68, whoſe Root 15. 5, ſubſtract from Q N 21.5, leaves 6, for Z N, to which G C is equal. Laſtly, as 16 to 20, ſo 6, to E A 7. 5, as required.

PROP. 25. *Fig.* 38.

There is a Plot of Land as A B C D, the ſides are B C 50, A D 38, A B 20, and D C 10, D and C Rectangles, it is required to be divided into two equal parts with Lines equally parallel unto B C and D C. The Queſtion is, how much is B E and G D?

Take D C 16, from D A 38, and there reſts for L A or L M 22. M C is 18, which added to D C 16, makes 44. Then as 44 to 22, ſo 16 to O A 8; and ſo 18 to O L 14; make C D ſo much longer as O A, then is C R 24, add M P 14, to M C 28, it makes P C 42; then ſeek the Area of the Quadrangle A B C D, which is 704; alſo ſeek the Area or Content of C R Q P, you will find 792, from this ſubſtract 352, being half A B C D, and there reſts 440, the content of S Q T F; then as 792 the Area of C R Q P, to 576, the ſquare of C R, ſo S Q T F 440 to 320, whoſe Root is 17. 89 for T F, which being ſubſtracted from Γ I 24, giveth F I 6. 11; then as 16. to A B 20, ſo 6.11 to E B 7. 64, the thing required.

PROP. 26. *Fig.* 39.

A Quadrangular Piece of Land, as A C D B, is required to be divided into two unequal parts, in such wise that the part cut off round about, be equally distant and parallel unto A B, A C, C D and B D, and to contain in quantity one third part of the whole Plot. The Question is how long is Y Z, H a, and likewise E b, and N c.

First, Divide the length A B into such parts as the whole Plot is to be divided into, as in this, into three; divide the breadth into 4 parts, as A G H I C, make C K equal to A E, of the length A B; draw then the Semicircle I L K, whose Center is on A C K, draw the Arch M L upon C, then is L C a mean proportional between I C and C K; divide C D into 2 equal parts, viz. N; unto which add L C, and it will come to Q, then let C Q be the Diameter of the half Circle C P Q, draw the line M P parallel to C D, until it touch the Semicircle C P Q, then is M P the length of E b, H a, Y Z, and t N, as was required.

CHAP.

Fig: 34.

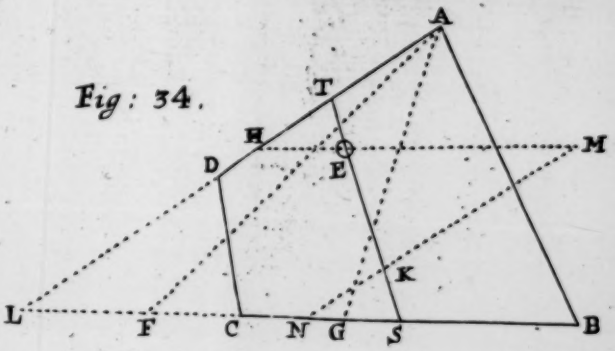


Fig: 35.

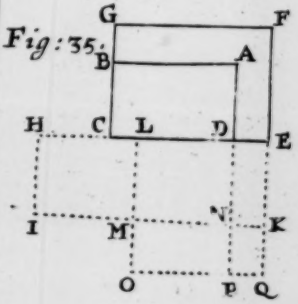
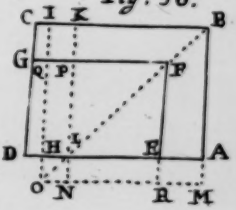


Fig: 36.



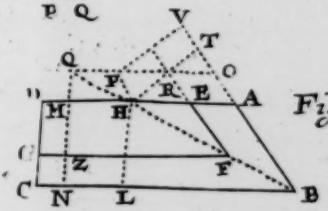


Fig: 37.

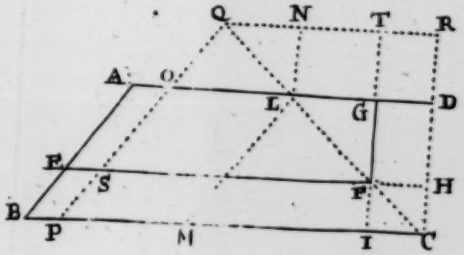


Fig: 38.

betweene pag. 132. 133.

CHAP. XLIX.

How to caſt up the true Content of any Piece of Land when you have the length of the Sides meaſured by Mr. Gunter's Decimal Chain, containing 4 Poles in length.

First, you are to conſider that 10 of Mr. *Gunter's* Chains in length, and one in breadth makes an Acre; each Acre contains 160 ſquare Pole; each Pole containing 16 Foot & a half; ſo by this means you will have 100000 ſquare Links in an Acre, becauſe there are 100 Links in a Chain; theſe things conſidered, reduce your Plot into Triangles or Trapeziums, as you were taught in *Chap.* 47. Having ſo done, multiply half the Baſe by the Sum of the Perpendiculars; if it be a Trapezium, in Chains and Links, as if they were whole Chains, and cut off 5 Figures toward the Right hand of the product, and thoſe Figures ſo cut off, will be the 100000 part of an Acre.

Example.

Let there be a Triangle, whoſe Baſe doth contain in length 44 Chains 00 Links, and the Perpendicular thereof doth likewiſe contain 22 Chains 00 Links in length; now the half of the Baſe is 22 Chains and 00 Links; now to ſet them down as if they were all Chains, the Work will ſtand as followeth.

Half the length of the Base	2206
The length of the Perpendicular	2200
	4400
	440
	48.40000

The 48, as you see on the left Hand of the Line is Acres, and the 40000 that is on the other side of the Line is the parts of 10000 remaining above Acres; that is, if you will divide an Acre into 100000 parts this 40000 is 40000 of those parts: But for the better turning of these Fractions into Roods and Poles, I have added a Table.

Roods	Decimal Tables.
	00000
3	75000
2	50000
1	25000
30	18750
20	12500
10	6250
9	5625
8	5000
7	4375
6	3750
5	3125
4	2500
3	1875
2	1250
1	625

Poles.

The use of this Table is thus; when you have a Fraction remaining on the right hand of the Line that you draw, when you cut off the 5 Figures, look for that Number in this Table, and by that means you will know how many Roods or Poles this Fraction doth contain.

Example. 1.

In the last Multiplication-Table you had 40000 set on the right hand of the Line, this 40000 look for in this Decimal Table, and the nearest to it will be 3750, which stands against 6 Pole; so there is 6 Pole more than 48 Acres, and then have you the Content of this Field to less than

half

half a Pole, which is but a very small matter in such a great Quantity.

Example. 2.

Admit you had 875 o left on the right hand of the Line as a Fraction, look for the nearest less in the Decimal Table, which is 75000, against which you find 3 Roods; this 7500 substract from 87000, and there remains 12500; this 12500 look for in the Decimal Table, and against it, you will find 20 Pole; this shews that there was 3 Roods and 20 Pole in this Fraction: So may you do for any other Fraction whatsoever that arises by the cutting off the 5 Figures to the right hand of the Product of your Multiplication.

CHAP. L.

How to take a Plot of a Lordship or Manor consisting of divers Severals, of what Nature or Kind soever, whether Wood, Grounds or other.

First, walk over the Lordship that you are to take the Plot of, to find out a convenient place to begin your Work; if there be a Lane or Lanes, take the Plot thereof first, noting down in your Field-Book where you find the Hedges to bend in or out, setting the distance you find on either side of the Chain, and call them Off-set to the right or left, as occasion serves. As for example;

Let Fig. 40 be the Mannor that you are to take the Plot of; firſt begin with the Lane, thus, placing your Inſtrument at A, with the Needle hanging over the Meridian-Line of the Chart, you muſt cauſe a man to ſtand at B with a piece of white Paper pinned on his Breſt, ſo that you may ſee it; then direct your Sights to the man's Paper on his Breſt, and note (the degrees cut by the Index) down in your Field-Book, with this Mark ⊙, to repreſent your Station; when you have ſo done, meaſure your Off-ſets with your Chains both to the right and left; this being done, take up your Inſtrument, and cauſe a man to ſtand in the place thereof, then meaſure the diſtance directly in a ſtraight Line towards B, and at 1 Chain 75 Links, I find the Hedge to have a Bend; then meaſure the Off-ſet from your Chain unto this Bend, which let be E Y; this 1 Chain 30 Links being the Off-ſet from E Y; note it down in your Field-Book, thus; at 1 Chain 75 Links, the Off-ſet to the Left was 1 Chain 30 Links; this being done, meaſure on to B, and the diſtance of A B will be found to be 3 Chains 74 Links; note this down in your Field-Book alſo; then placing your Inſtrument at B, lay the Index on the Diameter thereof, and turn your Inſtrument about till through your Sights you ſee the man at A; there make your Inſtrument faſt: then cauſe the man that ſtood at B, to go to C; then direct your Sights to C, and note the degrees cut by your Index down in your Field-Book, and meaſure your Off-ſets both to the right and left, and note them down in your Field-Book alſo; then meaſure the diſtance of B C, which let be 3 Chains 5 Links, which note down likewiſe in your Field-Book; then take up your Inſtrument from B, and cauſe a man to

ſtand

ſtand in the room thereof, and place it at C, and laying your Index on the Diameter, turn your Inſtrument about till through the Sights you ſee the man at B; there make your Inſtrument faſt: then cauſe a man to go to D, and ſtand there; then turn your Index about till through your Sights you ſee the man at D; then note down in your Field-Book the degrees cut by the Index; then meaſure the Off-ſets both to the right and left, and note them down in your Field-Book alſo; then meaſure the diſtance of C from D, and note that down in your Field-Book, and at the end, *viz.* at D, meaſure the Off-ſets both to the right and left, and note them down in your Field-Book as you have done the reſt; ſo ſhall you have finiſhed your Lane: and if you have noted them down in your Field-Book according to the Directions given, they will ſtand thus.

Station.	*deg.*	*min.*	*C.*	*L.*	*R.C.*	*R.L.*
1 ⊙A	113	30	—	—	—	—
— A E	—	—	1	75	—	1.30
2 AB	—	—	3	74	—	—
2 ⊙B —	131	00	—	—	1.00	0.45
BC	—	—	3	05	—	—
3 ⊙ — D	240	00	—	—	0.60	0.40
CD	—	—	4	00	1.00	1.00

When you have ſo done and protracted, you will find you will have one or two Sides in every Field laid down.

☞ But note when you are taking the Plot of a Lane, if you find there comes a Hedge and joyns to the

the Hedge that is on the other side of the Lane, you were best note it down in your Field Book with this Mark —|—; if it be on the left hand, note it on the left hand of the Letters, and if on the right, note it on the right, as you see; there is a Hedge come down to Y against E, therefore against A E put the Mark as you see in the Table; and the Benefit you will find when you come to Protraction. The next thing you are to do, is to go into each Field by it self, and take the rest of the Sides of the Field that are not protracted. Observe these Rules, and you will find it very easie, speedy and true; Admit you were to take the rest of the Lines of *Well-Close* in *Fig.* 40. you having the Side F I given, first measure 50 Links with your Chains from the Angle F, upon the Side F I; which let be *e g*; then cause 2 men to stand, one at *e*, and the other at F in the Angle, each of them holding one end of the Chain in their hands, let the Surveyor take the middle or any part of the Chain in his hand, and so stretch it out straight, and where the middle of the Chain falls there let him place his Instrument, and laying the Index upon the Diameter, let him turn his Instrument about till through the Sight he see the Mark placed at the Angle at F; then direct your Sights to G, and note the degrees cut by the Index down in your Field-Book; this will be all the Angles you will have occasion to take in both the Fields that lie together; then measure the distance from T, your new Station in *Well-Close*, to G, and note this down in your Field-Book, then measure the distance or length of the Hedge G H, and note this down in your Field-Book; then measure the length of the Hedge I H, and note this down in your Field-Book; so have you done with *Well-Close*: this

you

you must note in your Field-Book, with the Tenant's Name, the Name of the Close, and the Tenure by which he holds the same: Then may you begin with *Oak-Close*, setting down the Tenants Name and Tenure he holds it by: Now considering that you had two Sides of this Field given by measuring the Lane, and a third side by measuring the Line I H in *Well-Close*, all that you have to do, is to measure the Side H L, which note down in your Field-Book, as you did *Well-Close* Sides; having so done, you may begin with any of the other Closes that are on the other side of the Lane: Admit you begin with *Barn-Close*, noting the Tenant's Name, and the Tenure by which he holds the same, down in your Field-Book, first consider that the side S V was given by measuring the Lane, measure off 50 Links along the side of the Hedge from S to *a*; at *a* let a man stand, and at the Angle at S let another stand, each of them having an end of the Chain in his hand; then let the Surveyor take up the Chain about the middle thereof, and let him hold out the Chain straight, and move himself up and down until he likes the place of standing for his station; which in our Example, is 60 Links from the Angle at S, and 40 Links from the man that stands at *a*, which is at *q*; then placing your Instrument at *q*, the Index lying on the Diameter, turn your Instrument about till through your Sights you see the man in the Angle S; there make your Instrument fast, and direct your Sights to a Mark placed at Q, and note the degrees cut by the Index down in your Field-Book; then with your Chain measure towards Q, and finding that at 1 Chain 77 Links there is an Angle at the Hedge, therefore measure the Off-set with your Chain, and finding it to be 4 Chains 70 Links,

Links, this 2 Chain 50 Links note down in your Field-Book Offset to the Right; then measure on till you come to Q, and finding it to be 4 Chains 70 Links, these note down in your Field-Book also; then have you done with your Semicircle for the rest of the Closes on this side of the Lane also; then with your Chain measure the length of the Hedge Q P, and note it down in your Field-Book, and measure the length of the Hedge P V, and note that down also in your Field-Book; then have you done with *Barn-Close*: Next begin with *Mill-Meadow*, noting the Tenant's Name, and the Tenure by which he holds the same, and considering you have two sides of this Field laid down by measuring the Lane, and that you have the third side given by measuring *Barn-Close*, there will be no need of measuring any other sides than P O and O Y, therefore measure with your Chain the length of the Hedge P O, and note it down in your Field-Book; then measure the length of the Hedge O Y, and note that down also; so have you done with *Mill-Meadow*; then begin *Hill-Close*, noting as before the Tenant's Name and Tenure by which he holds the same; and considering that one side of this Field was measured when you took the Lane, and another when you measured *Mill-Meadow*, *viz.* the Hedge O Y, then have you only the sides O N and N M to measure; therefore with your Chain measure the length of O N, and note that down in your Field-Book; then measure the Hedge N M, and note that down also; which when you have done, observe in what order these things taken stand in the Table following, and you will be able to do the like: But this one thing let me advise you to do; when you go over the Manor to see where you shall

shall begin your Work, take an Eye-draught of the Manner, noting the Hedges, Lane and Angles of the Field with a Pen upon a piece of Paper; so shall you be able to see your Work as you go along, and set down the Angles and length of the Sides upon your Eye-draught as you go along; this is the readiest way that I know to prevent mistakes in Protraction; however here follows the Table.

John James's Well-Close free.

Marks	*Chain*	*Link.*	
F *g.*	00	50	The Off-sets from the Hedge for the finding of a Station.
g T.	00	40	
F T.	00	60	

The ⊙ at T is 40 deg. The length of T G is 3 Chains, 30 Links.

The Bounding of the Limits.

G H	6	30	The Common.
I H	4	20	The Oak-Close.

Robert Roe's Oak-Close for Life.

The Bounding of the Lines.

I H	4	20	Well-Close.
H E	4	78	Cow-Pasture.

Widow *Barnes* Barn-Close for Life.

S *a*	00	50	The Off-sets from the Hedge for the finding of a Station.
S *q*	00	60	
q a	00	40	

Marks

Marks.	Chain	Link.	d.	'	R		
⊙ 1	00	00	18	15	C.	L.	Off-sets.
S 1	1	77	0	00	1.	50	
S Q	4	70	—	—			
Q P	3	00	A River.				
P V	3	20	Mill-Meadow.				
The Bounding of the Lines.							
P O	3	83	The River.				
O Y	4	60	Hill-Close.				
The Bounding of the Lines.							
O N	2	80	North-Field.				
N M	2	55	The Road.				

In this Table is contained the Lengths of the Hedge, and those Stations that you make use of. ⊙ doth represent the Station, and G the Angle you direct your Sights to, and T G is the length thereof: The second Station you made was at 1, and the Angle you directed your Sights to was Q, and the Length of that Line was S Q; after this manner may you set down your Work in your Field-Book; but it will be very convenient to make an Eye-draught of all your Inclosures, and that being done, there's no fear of mistaking when you come to Protraction, because you will have the view of all your Work.

The Protraction follows.

CHAP.

CHAP. LI.

How to protract or lay down any Observation taken according to the Work of the last Chapter.

PRovide a Skin of Velom or Parchment, or divers Sheets of Paper neatly fastned together with Starch or Mouth-glew, which is the best (according to the greatness you intend your Plot to be;) then at a convenient place thereof draw a Line to represent your Meridian-Line; then laying the Table that you made when you took the measure of the Lane (laying the Center of your Protractor on the Point A, with the Meridian-Line thereof lying on the Meridian-Line you have drawn on the Paper) you find in your Table that you had an Angle of 113 : 30; therefore against 113 ; 30 of the Protractor make a Mark with your protracting-pin ; then draw the Line A B, and finding that the length of the Line A B in the Table is 3 Chains 74 Links, take that off from your Scale of equal parts, and place it from A B; this done, place the Center of your Protractor on the point B, letting the Line A B thereof lie on the Line A B that you have last drawn; then finding that at B you obferved an Angle of 131 deg. against 131 deg. of your Protractor make a Mark, and draw the Line B C at length; then because your Line B C was measured to be 3 Chains 5 Links, take that likewise from

off

off your Scale of equal parts, and place it from B to C; then placing the Center of your Protractor on the point C, with the Line A B thereof lying on the Line C B that you have last protracted; then because at C you observed the Angle to be 240 deg. against 240 deg. of your Protracton, make a Mark with your protracting-pin, and draw the Line C B at length; and because the length of the Line C B was measured to be 4 Chains, these 4 Chains take off from your Scale of equal parts, and set it off from C to B; then have you done with protracting your Stationary Lines; now begin to protract your Off-sets, thus; Look in your Table or Field-Book, and finding that the Off-set at A, your first tation, was 50 Links to the Right hand, and to the Left 60 Links, these 50 Links take off from your Scale of equal parts, and place them from A your Station, to F; in the same manner must you take off 60 Links from your Scale, and place them from A M; this done, go to the next; thus; finding that at 3 Chains 74 Links on the Line A B you had an Off-set to the Left hand to be 1 Chain 30 Links, this 1 Chain 30 Links you must likewise take off from your Scale of equal parts, and place from E to Y, and draw the Line M Y; then finding also at your second Station B, your Off-sets to be 1 Chain to the right hand, this 1 Chain take off from your Scale, and place it from B to I (and because that at your former placing your Off-sets there was a hedge butted, and at this also, therefore make a Mark to signifie the same) and draw the Line E I; then finding also that at your Station B, the Off-set to the left was 45 Links; this 45 Links take off from your Scale of equal parts, and place it from B to Z, and draw Y Z; then finding by your Field-Book that at your

your third Station C, the Off-ſet to the right was 60 Links, this 60 Links take off from your Scale of equal parts, and place it from C to K, and draw the Line I K: at your Station C, you had the Off-ſet to the left 40 Links; this 40 Links take off from your Scale, and place it from C to V, and becauſe at V you had a Hedge bounded, at V make a Mark to ſignifie the ſame; then finding by your Field-Book that at your laſt ſtation D, you had the Off-ſet to the right to be 1 Chain, this 1 Chain take from off your Scale, and place it from D to L; and the Off-ſet to the left at the ſame time was one Chain alſo; this one Chain take off from your Scale as you did the other, and place it from D to S, and draw the lines K L and V S, then have you done with your Lane (I would have the young Surveyor to be well acquainted with this manner of plotting of a Lane; for in the ſecond part of this Book he will come to make much uſe of it in the drawing the Map of a Town or City.) Now muſt you begin to plot each Cloſe, and beginning at *Well-Cloſe*, you find at the Angle F, that F *g* was noted down in your Field-Book to be 50 Links; this 50 Links take off from your Scale of equal parts, and place it from F to *g*, on the Line F I; then finding alſo that *g* T was 40 Links, this 40 Links take alſo from your Scale of equal parts, and ſetting one point of your Compaſſes in the point *g*, with the other ſtrike a ſmall Arch; then finding that F T is 60 Links, theſe 60 Links take off from your Scale of equal parts, and ſetting one point of your Compaſſes in the point F, with the other interſect the laſt Arch made, and that point of interſection is the point T, your Station; then draw the Line F T at length, and placing the Center of your Protractor on the point T,

let the Line A B thereof lie directly on the Line F T laſt drawn; then finding that the Mark in the Angle G was obſerved to be 40 deg. the Semicircle of the Protractor being downwards, with your protracting-pin make a Mark againſt 40 deg. of your Protractor, and draw the Line T G; and finding by your Field-Book that the length thereof was meaſured to be 3 Chains 30 Links, this 3 Chains 30 Links take off from your Scale, and place it from T to G; this done, draw the Line F G; then finding by your Field-book the length of the Hedge G H was meaſured to be 6 Chains 30 Links, take this 6 Chains 30 Links from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point G, with the other deſcribe a ſmall Arch; then finding by your Field-Book that the length of the Hedge I H was meaſured to be 4 Chains 20 Links; theſe 4 Chains 30 Links take from off your Chain of equal parts, and ſetting one foot of your Compaſſes in the point I, with the other interſect the Arch before deſcribed, which point of interſection will be the point H; then draw the Lines G H and I H, and you have protracted *Well-Cloſe*; then begin to protract *Oak-Cloſe*; thus, ſeeing you had 2 ſides thereof laid down by protracting the Lane, and the third ſide by protracting of *Well-Cloſe*, and there is left but one ſide for you to protract, *viz.* H L, therefore draw H L, and you have done with that Cloſe alſo; thus having finiſhed the Incloſures on the right hand of the Lane, begin to protract them on the left ſide of the Lane, thus; finding by your Field-book that S *a* was meaſured to be 50 Links, this 50 Links take off from your Scale of equal parts, and place it from S to *a* upon the Line S V; then finding in your Field-book that *a q* was 40 Links,

Links, this 40 Links take from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point *a*, with the other deſcribe a ſmall Arch; finding alſo that S *a* was 60 Links, this 60 Links being taken off from your Scale of equal parts, and ſetting one foot of your Compaſſes in the point S, with the other interſect the laſt ſmall Arch drawn; which point of interſection will be the point *q*, the place where you did ſet your Inſtrument; then draw the Line S *q* at length, and laying the Center of your Protractor on the point *q*, let the Line A B thereof lie directly on the Line S *q* laſt drawn, with the Semicircle thereof upwards; then with your protracting-pin make a Mark againſt the Angle obſerved, (which you will find in your Field-Book to be 18 deg. 15 min.) and draw the Line S Q at length; then finding by your Field-book that at 1 chain 77 links upon that line you had an Off-ſet to the right, which was 1 chain 50 links, therefore take off 1 chain 50 links from your Scale of equal parts, and place it upon the line S Q, from S to *l*; then take off 1 chain and 50 links from your Scale, and place it from *l* to R, and draw R S; then take off 4 chains 70 links from your Scale of equal parts (it being the whole length of the line S Q, as by your Field-book doth appear) and place it from S to Q, and draw R Q; then finding that the length of the Hedge Q P (in your Field-book) is 3 chains, theſe 3 chains take off from your Scale, and ſetting one foot of your Compaſſes on the point Q, with the other deſcribe a ſmall Arch towards P; then finding that the length of the Hedge V P was meaſured 3 chains 20 links, take this alſo from your Scale, and placing one foot of your Compaſſes on the point V, with the other interſect the

laſt Arch deſcribed; which point of interſection will be the point P; then draw the lines Q P and V P, and you have finiſhed *Barn-Cloſe*: then begin with *Mill-Meadow*; and ſeeing there were 2 ſides protracted when you meaſured the Lane, and the third ſide when you protracted *Barn-Cloſe*, there remains but 2 ſides to protract, and they muſt be done thus; Finding in your Field-book that the length of the ſide P O is 3 chains 83 links, theſe chains and links being taken from your Scale of equal parts, and ſetting one foot of your Compaſſes on the point P, with the other deſcribe a ſmall Arch towards O; that done, take off the length of Y O, which in your Field-book you will find to be 4 chains 60 links; then ſetting one foot of your Compaſſes in the point Y, interſect the laſt Arch drawn, which point of interſection will be the point O; then draw the lines P O and Y O, and you have finiſhed *Mill-Meadow*; then begin with *Hill-Cloſe*; and finding alſo that you have two ſides thereof protracted, and that but two ſides remain to be protracted, theſe two ſides muſt be laid down thus; finding in your Field-book that the length of the Hedge O N is meaſured to be 2 chains 80 links, take theſe chains & links from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point O, with the other deſcribe a ſmall Arch towards N; then take off the length of your Hedge M N, (which is found to be 2 chains 55 links) from your Scale of equal parts, and ſetting one foot of your Compaſſes in the point M, with the other interſect the ſmall Arch laſt drawn, which point of interſection will be the point N; then draw the lines O N, and M N, and you have finiſhed your Plot. If you follow the Rules given in this Chapter and the foregoing,

going, though of a mean capacity, you may know how to take the Plot of any Mannor, let it be never ſo large.

☞ Note, Any one may take the Plot of a Mannor by plotting Cloſe by Cloſe, by going about the ſame, and the Rules before going will be ſufficient to perform any work of that Nature; but let any one but try that way, and when he has done, try this which I have ſhewed in the foregoing Chapters, and he will be able to judge which way will be the moſt ſpeedy and exact. I have found out this way by experience, and therefore recommend it to Poſterity, that others may try their experience upon it as well as my ſelf; for I am certain there is not half the trouble in it as in thoſe ways that have been formerly treated on by Authors; and as for the exactneſs thereof, Experience muſt be Judge; till then let no one condemn it, leſt he prove himſelf a Carper.

CHAP. LII.

How to reduce a Plot to a greater or leſſer Quantity according to any proportion.

HAving protracted your Plot according to the former Directions of the laſt Chapter, if you find it to be greater or leſs than your intended or confined Limits, you may reduce it into a ſmaller or greater according to any proportion aſſigned; to do which, provide a Ruler of what length you pleaſe, which muſt be divided into 100 equal parts, and numbred as in *Fig.* 41. From C to A and through the Center C, is a little Hole made, ſo that you may put in a Pin or Needle to faſten it unto the Table, and yet the Ruler have its play about the Center C: Now admit you were to reduce the Plot that was laſt drawn into half the bigneſs that now it is, firſt, faſten the Plot unto the Table at the 4 corners with Paſte or Mouth-Glew, the right ſide of the Plot lying uppermoſt; then lay another Paper or Parchment thereupon of your intended bigneſſes, faſten it at the four corners likewiſe unto the other Plot, ſo that the Center or middle of the leſſer Plot may be upon the Center of your greater; near the middle of your Plot place the Center of your Ruler, and faſten it down with a Pin or Needle, ſo that it may play about; this done, you may begin to reduce your Plot: Suppoſe you were to begin at G, turn your Inſtrument or Ruler about until you come at G, and ſuppoſe it meets with

with 80 parts of the Ruler; and becauſe the Plot is to be reduced to half its bigneſs, take half of 80 parts which is 40, and againſt that Diviſion of the Ruler make a Mark upon your Paper with your protracting-pin.

Then turn your Ruler about to H, and finding that it cutteth 70 equal parts upon the Ruler, the half whereof being 35, make a Mark upon your Paper againſt 35 equal parts of your Ruler.

Then bring your Ruler about to I, where it cutteth 60 equal parts, the half whereof being 30, make a Mark againſt 30 of your Ruler upon your Paper.

In this manner muſt you do, *viz.* bring your Ruler unto all the Angles of the Field, *viz.* S R Q P O N M Y Z V K I F; then by theſe new Marks draw Lines upon your Paper, as the Lines G H, H L, L K, K I, and I F; and if you do ſo by all the reſt of the pricks that you have made upon your Paper, you will have the true ſemi-proportion of your Map; thus muſt you do with all other meaſures be they never ſo many.

☞ Note, When you come towards the middle of your great Plot, then unpaſte two of the Corners of your leſſer Plot, and fold it backward, the face of your new Plot towards the face of your old Plot, and by that means you may come to ſee the Angles that lie near the Center of the great Plot.

In the like manner may you enlarge a Map of any Mannor by doubling or trebling your Numbers found, and by this means you may ſpeedily and exactly perform the ſame. This Ruler was the Invention of Mr. *Rathborn*: There is another way for the reducing of Maps, and it is this; Take that Plot or Map which you are to reduce, and on the edge thereof, divide a Line into a Number of equal parts all

round about the ſame, and by that means you may fill your Map full of Squares to what largeneſs you pleaſe; when you have ruled your Map into Squares, you muſt do the like by the Paper upon which you intend to have your leſſer draught: Only note that the Squares are made leſs according to the proportion that you intend it ſhall bear to the larger; this being done, you may proceed in this manner; Look in which of the ſmall Squares in the foul Plot or Map you ſee the ſeveral Angles or remarkable Points fall, and then in the correſpondent Squares of the fair Paper make the like Angles or Points; in this manner proceed till you have finiſhed your Work.

This is the beſt and exacteſt way that can be, and is the courſe that all thoſe take that enlarge or diminiſh a Draught, *viz.* the Painters and thoſe that copy County-Maps.

CHAP.

CHAP. LIII.

How to draw a perfect Draught of a Manor or Lordſhip, and to deck and beautifie it.

HAving by the former Rules protracted your Plot acccording to the intended bigneſs, and written the content of each Cloſe, in or about the middle thereof, you may about the bounds of every Field or Encloſure with a ſmall Pencil, and with ſome tranſparent colour neatly go over your black Lines, ſo ſhall you have a tranſparent ſtroke on either ſide of your Paper, which being ſhadowed thus, will add great beauty to your Map.

Upon thoſe Cloſes that be woody, may be drawn divers little Trees in the moſt material places; you may likewiſe ſhadow your Mountains and uneven grounds with Hills and Dales, expreſſing all High-Ways and Rivers in that colour that may moſt likely repreſent the thing.

Likewiſe in ſome convenient place of your Map deſcribe a Compaſs with the 32 points thereof, according to the ſituation of the Grounds with a Flower-de-luce at the North-end thereof.

Likewiſe place a Scale of the ſame bigneſs of that by which you drew your Plot, with a pair of Compaſſes opened upon the ſame.

In ſome other ſquare place towards the upper end thereof

thereof, draw the Coat of Arms belonging to the Lord of the Mannor, with Mantles, Helm and Creſt, or in a compartment; you muſt be ſure to emblazon the Coat in its proper Colours; likewiſe in your Plot expreſs the Mannor-Houſe, according to its ſituation and bigneſs.

Theſe things being well performed, you will have a neat Map of the Mannor for the Lord thereof to hang up in his Study or other private place, and ſo at pleaſure he may ſee his Land before him, and the quantity of all or every Parcel.

For your better inſtruction I have added the Figure of a ſmall Mannor, which will be ſufficient for example, in *Fig.* 42.

CHAP. LIV.

How a Mannor or Lordſhip lying in a common Field is to be encloſed.

WHen a Lord of a Mannor and the Freeholder thereof are minded to have their Ground improved, and they come to the Surveyor to incloſe the ſame, let him begin thus;

Firſt, He muſt prepare a Field-Book that is ruled on the right hand thereof with divers black Lines, to expreſs the length, breadth and Content of each Furlong, with the Freeholder's Name; this being done, when the Surveyor comes into the Field, let him begin at one corner thereof, as he ſhall find moſt con-

convenient; noting upon what point of the Compaſs he doth begin, firſt ſetting down the Freeholder's Name in the large Column towards the left hand; then meaſuring the length of the Freeholder's Furlongs, and ſet that down in the next Column towards the Right hand in Chains and Links; then meaſure the breadth of the ſame Furlongs, and note that down alſo in Chains and Links in the next Column towards the right hand; ſo muſt you do for all the Freehold-Land in the Field.

☞ But here note, you muſt not begin to meaſure any other mens Parcels till you have made an end of meaſuring the Parcels that do belong to the man whoſe Name you firſt ſet down; for it oftentimes happens that a man hath 5 Lands lying here, and 5 or 6 Lands lying in another place of the ſame Field. When you have collected the length and breadth of every man's particular Lands into your Field-Book, you muſt alſo find the content of each man's particular, and ſet that down alſo in another Column towards the right; when you have done with one Field, then begin with the next, noting what Field it is at the Head of the Table; as follows.

Weſt-

West-Field	*Length*		*Bread.*		*Content.*		
	C.	*L.*	*C.*	*L.*	*Acr.*	*R.*	*P.*
John Wood's from the *Church-Lane* Eastw.	12	57	2	20	2	3	2
William Brown's ——	11	64	3	7	3	2	11
Francis Jackson's ——	9	30	2	5	1	3	22
Thomas Tomlinson's—	8	40	2	20	1	3	15½
William Barker's ——	7	6	5	25	3	0	32
Edward Williamson's—	6	5	3	20	1	3	30
John Parker's ——	13	20	8	40	11	0	14
Thomas James's ——	10	10	7	30	7	1	19½
Robert Thomas's ——	5	50	8	30	4	2	10½
John Tring's ——	6	10	6	80	4	0	23½

When you have finished one Field, you must begi with the next, and do in all respects as you did wit the first, making a Table thereof and in the Meadow also you must take each man's Several; this being done you must plot the whole that is to be inclosed, accor ding to the Rules of the foregoing Chapters; which being done, you will see whether the general Surve and the particular agree; which if they do, you ma conclude your Work to be exactly taken; if not, yo must go over the Field, and find out your Error.

The next thing that you are to do, is to plot the Sum of each man's Land that he hath in all the three Field together, and lay it out in such part of the Fiel as the Freeholders (or their Arbitrators) shall agree into several Inclosures; thus:

The

The Arbitrators tell you that ſuch a man ſhall have ſo many Acres laid in a Cloſe, here the breadth being ſo much in length, they demand of you how long that Cloſe muſt be to contain ſo many Acres? For the doing of which, obſerve this Rule: Multiply the number of Acres by 160, the ſquare Poles in an Acre, and this product divide by the length of the Side of the Field that they give you, and the Quotient will be the length of the Cloſe.

Example.

Admit a man were to have 10 Acres laid out in a Cloſe, and the breadth of the ſame Cloſe being given to be 50 Poles in length, theſe 10 Acres being multiplied by 160, the ſquare Poles in an Acre, the ſum will be 1600, and that being divided by 50, the breadth of the Field given, the Quotient will be 32 Poles that the length of the Cloſe muſt contain the other way.

Operation.

The given Content of the Cloſe 10 Acres, being multiplied by the ſquare poles 160 in an Acre,

The Product 1600

The Breadth of the Cloſe 50) 1600 (32 the length of the Cloſe
1

This being found, firſt cauſe a Ditch to be made that ſhall contain 50 pole, the Breadth given; and alſo cauſe another Ditch to be made in a right Angle to the other, that ſhall contain 32 pole, the length found; this being done, make a Parallelogram there, by digging of Ditches parallel to the other two before

fore made, ſo ſhall you have a Cloſe that will cont
10 Acres of Land.

After this manner muſt you proceed with all t
reſt, laying each mans quantity together in Cloſes,
the Arbitrators ſhall think fit, and then you ha
done with incloſing the Field.

Laſtly, Draw a Plot of the Town, with the Stree
Lanes, Houſes, Woods, and all the new Incloſure
which being garniſhed with Colours upon Velam
Royal Paper, will moſt neatly ſhew the true propor
tion and Symetry thereof.

Let there be alſo a Book drawn very fair, ſhewin
the butting, bounding and quantity of every Grou
of all the whole Mannor.

CHAP. LV.

How to reduce one kind of meaſure into ano ther, as Statute-meaſure to Cuſtomar Meaſure, and the contrary.

FIrſt, The young Surveyor muſt take notice tha a Statute-pole doth contain 16 foot and one hal and an Acre of Ground doth contain 160 ſquare pol of that length; but in many places of this Lan (through long cuſtom) there hath been received othe Quantities called Cuſtomary; as namely, of 18, 2 24 and 28 foot to the Pole or Perch; it is therefor of extraordinary uſe for a Surveyor to know readil how to reduce Cuſtomary Meaſure to Statute-Mea ſure

ure, and the contrary; to perform which, ſeek what proportion 16 foot and an half doth bear unto 18 foot; to do which, obſerve this Rule: Firſt, turn your 16 and an half into halfes, and that makes 33 halfes; then turn 18 foot into halfes alſo, and that will be 36; ſo 33 will be a Numerator of a Fraction to 36, and then it will ſtand thus; $\frac{33}{36}$: but the one third of the Numerator being taken, and the one third of the Denominator alſo, it will ſtand thus, $\frac{11}{12}$; ſo by this means you will ſee that 16 foot and an half bears ſuch proportion unto 18 foot, as 11 doth bear to 12; wherefore you muſt ſquare 11; and that will be 121; and if you ſquare 12, it will be 144; then you will find that the Square of 11, *viz.* 121 doth bear as much proportion unto 144, the Square of 12, as 16 foot and a half doth bear to 18 foot.

Therefore if you will reduce Cuſtomary Meaſure into Statute-Meaſure, you muſt multiply the Cuſtomary Acres (being turned into Poles) by 144, and that Product being divided by 11, the Quotient will be Statute-Poles, which you may turn into Acres by dividing the Quotient by 160.

Example.

Admit you had 3 Acres, 2 Roods, and 20 Poles of Cuſtomary Meaſure; theſe 3 Acres, 2 Roods, 20 Poles being turned into Poles, is 580 Poles, this 580 Poles being multiplied by 144, the Product will be 83520; this being divided by 121, the Quotient will be 690; this 690 being divided by 160, the Quotient will be 4 Acres, 1 Rood, 10 Poles.

There

There is another way to reduce Cuſtomary meaſure into Statute, to be performed by Multiplication only by a Table.

A Decimal Table.

Feet.	*The Decimal.*
18	11901
20	14692
21	16198
24	21154
28	28802

The uſe of this Table is thus; When you have Cuſtomary Acres to be reduced into Statute, firſt turn the Acres into Poles, and then if your Cuſtomary Meaſure was 18 foot to a Pole, you muſt take the Decimal belonging to 18 foot, and multiply the poles by that, and cut off 4 Figures towards the right hand, and you will have Statute-meaſure, and thoſe parts that are cut off, are part of a Pole; the whole Pole being divided into 10000 parts.

Example.

Admit you have 580 ſquare poles at 18 foot the pole, and you would know how many poles it is at 18 foot and ½, this 580 ſquare poles multiply by 11901 the Decimal againſt 18 foot, the product will be 6902580, and the 4 Figures being cut off towards the right hand, there doth remain 690 ſquare pole, and 2580 parts of a pole, the whole pole being divided

ded into 10000 parts. But if you would reduce Statute-meaſure into Cuſtomary meaſure, obſerve this Rule; Multiply your Statute poles by 121, and that product divide by 144, and the Quotient will be Cuſtomary poles at 18 foot the pole.

Example.

Admit you had 690 ſquare poles at 16 foot and ½ each pole; this 690 being multiplied by 121, the product will be 83490, and this product being divided by 144, the Quotient will be 580 very near: But to perform this by a Decimal Table is better; and may be performed by Multiplication only.

A Decimal Table.

Feet.	*The Decimals.*
18	8403
20	6806
21	6173
24	4619
28	3472

The Uſe of this Table is thus; Multiply the given Statute-poles by the Decimals belonging to the Cuſtomary meaſure that you are minded to reduce it into; and cut off 4 Figures towards the right hand, and you will have your deſire.

Example.

Let 690 ſquare poles of 16 foot and $\frac{1}{2}$ be reduced into poles of 18 foot; multiply 690 by 8403, and the product will be 579|8070, the 4 Figures being cut off towards the right hand, the remainer will be 579 ſquare, and 8070 of 10000 of another, which wants but very little, as before.

This may be performed by the Logarithms with more eaſe, becauſe it may be done by Addition only.

The Table to perform it by.

Feet.	*Logarithms.*
18	0.075578
20	0.167092
21	0.209471
24	0.325400
28	0.459341

The Uſe of this Table is thus; To reduce Cuſtomary meaſure into Statute-meaſure, you muſt add the Logarithm of the given quantity of ſquare poles to the Logarithms of the Cuſtomary, and their Sum will be the Logarithm of the quantity of Statute-poles.

Example.

Admit you had 580 ſquare poles at 18 foot a pole, and would know how many ſquare poles it was at 16 foot and a half.

Againſt 18 in the Table the Logarithm is	0.075578
The Log. of the given Quantity 580 is	2.763428
	2.839006

The

The neareſt Log. in the Table of Log. is 2.838849, which is 690, and ſo many ſquare Poles very near.

But if you would reduce Statute-Meaſure into Cuſtomary Meaſure, you muſt uſe this following Table.

Feet.	*Logarithms.*
18	0.924434
20	0.832892
21	0.790496
24	0.664548
28	0.540579

The Uſe of this Table is thus; Add the Logarithm of the given Quantity of Statute-Meaſure to the Log. of the Cuſtom, and their Sum will be the Logarithm of the Number of Cuſtomary Acres that doth contain ſuch a Quantity of Statute-Acres.

Example.

Admit you had 690 Poles at 16 foot and an half a Pole, and it were required how many ſquare Poles are contained in that Quantity at 18 foot the Pole?

The Log. againſt 18 in the Table is	0.924434
The Log. of the given Number 690,	2.838849
The Log of 579:8	3.763283

Which wants but very little of 580, as before.

☞ Note, theſe Tables wherein you ſee Decimal parts againſt each Number, are made thus; In

the firſt Table, as the Square of a Pole containing 16 foot and an half, is to the Square of a Pole containing any number of feet, ſo is one Pole divided into 10000 parts, to a certain number of thoſe parts, which parts ſtand againſt their reſpective Number.

For the making of the Decimals in the ſecond Table, for the reducing of Statute-meaſure into Cuſtomary, the proportion will run thus; As the Square of a Cuſtomary pole is to the Square of a Statute-pole, ſo is one pole divided into 10000 parts to a certain number of thoſe parts; which parts ſtand againſt each reſpective Number in the ſecond Table: The third Table is the Logarithms of Decimals in the firſt Table; and the fourth Table is the Logarithm of the Decimals in the ſecond Table.

CHAP. LVI.

How to find whether Water may be conveyed from any Spring-Head to any appointed Place.

TO perform which, make uſe of an Inſtrument called a *Water-Level*; the making whereof is well known to Mr. *Hayes* at the *Croſs-Daggers* in *More-Fields* near the *Pope's-Head*: They are uſually made about 4 or 5 foot long, having a Trough or Copper-Pipe to hold the Water, and 2 Cups at each end one, into which the Water ought to run, ſo that the Surveyor may behold it; and by that means he comes

comes to know when his *Water-Level* is Horizontal; for when each Cup hath an equal quantity of Water, then is your *Water-Level* right, otherwiſe not: Beſides this Pipe or Trough, there ought to be two Sights alſo, and another Level for a Plummet, and a Staff to ſtand alwayes of an equal height, and two Station-ſtaves with moveable Vanes upon them, to move up and down at pleaſure, as ſhall be directed by him that ſtands at the *Water-Level*; In this manner are *Water-Levels* uſually made. As for the uſe thereof, obſerve theſe Directions following.

Standing at the Spring-head, ſet your ſelf in a ſtraight line as conveniently as you can, towards the place where the Water is to be conveyed, as at 30, 60, or 100 yards; then cauſe a man to ſet up one of your Station-ſtaves (it being divided into Feet, Inches, and parts of Inches) which Man call your *firſt Aſſiſtant*; then cauſe the ſecond man to go and erect the other Station-ſtaff beyond your Inſtrument at 30, 60, or 100 yards forwards towards, the place to which the Water ſhould be conveyed; the Station-ſtaves being erected perpendicular, and your *Water-Level* ſtanding exactly in the middle way between your Station-ſtaves, move it up and down until you find it preciſely horizontal; then go to the end of your *Water-Level*, and looking through the Sights, cauſe your firſt Aſſiſtant to move a Sheet of white Paper up and down your Station-ſtaff, till through the Sights you ſee the very edge thereof, and then by ſome known Sign or Sound, intimate to him that the Paper is then in its true poſition; then let this firſt Aſſiſtant note againſt what Number of Feet, Inches and Parts of an Inch the edge of the Paper reſteth, which let him note down upon Paper; then going to the other end of your

Water-Level (it remaining in the ſame poſition) and looking through the Sights towards your other Station-ſtaff, cauſe your ſecond Aſſiſtant to move a Sheet of Paper up and down, until through your Sights you ſee the very edge thereof; and then (by ſome known Sign or Sound) cauſe him to take notice of the the Number of Feet, Inches and parts of an Inch that the edge of the Paper doth cut; which let him note down in a piece of Paper alſo.

Having thus done, cauſe your firſt Aſſiſtant to bring his Station-ſtaff from the Spring-head, and cauſe your ſecond Aſſiſtant to take that ſtaff the firſt Aſſiſtant brought from the Spring-Head, and carry it forward towards the place to which the Water muſt be conveyed, 30, 60 or 100 yards, and there erect it perpendicular, as before, letting your firſt Aſſiſtant ſtand at that ſtaff where your ſecond Aſſiſtant ſtood before; then in the Mid-way between your two Aſſiſtants, place your *Water-Level* exactly Horizontal, & looking through your Sight, cauſe your firſt Aſſiſtant to move a Sheet of white Paper up and down as he did at the Spring-head; then by a ſign or ſound cauſe him to note down in a piece of Paper what Number of Feet, Inches and parts of an Inch are cut by the Paper; then going to the other end of your *Water-Level*, look through the Sights, and cauſe your ſecond aſſiſtant to move a Paper along the ſtaff, and to note the Feet, Inches and parts of an Inch as before; then cauſe your firſt Aſſiſtant to bring away his Station-ſtaff, and cauſe your ſecond Aſſiſtant to take it and carry it 30, 60 or 100 yards forwarder towards the place to which the Water is to be conveyed; and leaving your firſt Aſſiſtant at the place where your ſecond Aſſiſtant ſtood, place your *Wa-*

cauſe

ter-Level again in the mid-way between your two Aſſiſtants, and looking through the Sights as before, cauſe each of them to move a Leaf of white Paper up and down their Staves, and note in their ſeveral Papers the number of Feet, Inches and parts of an Inch cut, when you looked through the Sights of your *Water-Level.*

In this manner you muſt go along from the Spring-head to the place to which you would have the Water conveyed; and if there be never ſo many Stations, you muſt obſerve in all of them the like exactneſs; and then by comparing of your two Aſſiſtants Notes together, you may eaſily know whether the Water may be conveyed from the Spring-head to the deſired place or not.

You muſt note, that in your paſſage between the Spring-head and the appointed place you muſt be ſure to keep your firſt Aſſiſtant at every Station between the Spring-head and the *Water-Level* (otherwiſe great Error may enſue) and your ſecond Aſſiſtant muſt alwayes ſtand between your *Water-Level*, and the place to which the Water is to be conveyed: By obſerving this Order in your Work, you ſhall have no confuſion, neither ſhall one of your Aſſiſtants take more pains than the other.

Having thus orderly proceeded from the Spring-head to the place appointed, call both your Aſſiſtants together, and cauſe them to give in their Notes of the Obſervations of each Station, and add them together ſeverally; then if the Note of the ſecond Aſſiſtant exceed or be greater than the Note of the firſt Aſſiſtant, take the leſſer out of the greater, and the remainer will ſhew you how much the appointed place, to which the Water is to be conveyed, is lower than the Spring-head.

Here follows the manner of keeping the Notes in two Tables that the Assistants are to write down.

The First Assistant's Note.				*The Second Assistant's Note.*			
Stations.				*Stations.*			
1	12	2	$\frac{2}{10}$	1	2	8	$\frac{7}{10}$
2	2	6	$\frac{7}{10}$	2	13	6	$\frac{1}{10}$
3	1	7	$\frac{6}{10}$	3	3	3	$\frac{2}{10}$
The Sum	16	5	$\frac{2}{10}$	*The Sum.*	19	7	$\frac{1}{10}$

By these Two Tables you may perceive that the Notes of the first Assistant collected at his several Stations, being added together, amount to 16 feet, 5 Inches, and 2 Tenths of an Inch; and the Notes of the second Assistant at his several Stations being added together, amount to 19 feet, seven Inches, and one Tenth of an Inch; therefore if you substract the first Assistant's Notes from the second's Notes, there will remain 3 feet, 1 Inch and 9 Tenths of an Inch; and so much lower than the Spring-head is the place to which the Water is to be brought according to a straight *Water-Level*; therefore the Water may easily be conveyed thither.

☞ Note, That if your second Assistant's Notes do exceed the first's; then is it impossible to convey the Water from the Spring-head to the intended place, (unless you mount the Water by some Engine, which will be a great Cost and Charge;) but if both your Assistant's Notes be equal, then there is a possibility of effecting it, if the distance be not too long, though with more Charge and Difficulty.

Note also, That it is the Opinion of most Authors that

that have written upon this Subject, that at every Miles diſtance there ought to be allowed 4 Inches and an half more than a ſtraight Level; that thereby the Water may have a ſmall Current.

You muſt note alſo, That if there be any Hill in the way between the Spring-head and the appointed place to which the Water is to be conveyed, you muſt either cut a Trench by the ſide of the Hill to lay Pipes equal to your ſtraight *Water-Level* with the former allowance, or you muſt bring it about the ſaid Hill, which will be more Charge. The New River that is brought from *Ware* to *London*, is forced to have a multitude of Turnings and Windings for that reaſon, to the great Coſt and Charge of the Undertakers. If there ſhould be a Valley, then make a Trunk or Trough of ſtrong Wood well underpropped with ſtrong pieces of Timber, and well Pitched or Leaded, after the ſame manner as the New River is in many places between *Ware* and *London*.

Note likewiſe, That ſometimes you muſt convey Water from a Spring-head to any appointed place by a crooked or winding way, becauſe ſome Springs will have too violent a Current otherwiſe; and for that reaſon, ſome men when they convey Water in Pipes, lay the Pipes one up and another down.

If you convey Water from a Spring-head in Pipes to any Conduit or Houſe, Leaden Pipes are good; but Earthen ones are better: but ſuch Wood as hath Roſin in it, *viz.* Fir, Alder or Pine, is beſt; but ſuch Wood cannot be had in all places, when Clay to make Earthen Pipes, may be had at an eaſie rate. They are burned and glazed in the manner as Earthen Pots; and they are made in ſuch ſort that they may ſhut one within the other, and are in form like unto a Butter-

Pot,

Pot, only one end is ſmaller than the other, and they are moulded ſo exact, that when one is ſhut in the other, there can come no Water out: Theſe kind of Pipes will lie a long time under ground before they decay (if they be but well burned.) I had once the happineſs to ſee Water conveyed in this ſort of Pipes, at *York*, by one *Thomas Man*, as he was conveying Water from a ſmall Spring to a Conduit in the high Pavement in the City of *York*; the Spring was at leaſt half a Mile (if not more) from the City; but I could not ſtay there ſo long to ſee him compleat it.

CHAP. LVII.

By way of Concluſion of this Firſt Part.

WHereas I have ſhewed you how to take the Plot of any Encloſure or Mannor, and to caſt up the true Content or Area thereof; but not having ſhewed you how to deal with Ground when it is Hilly or Daly, I think it not amiſs to inſert it here; and it is thus.

When you are taking the Plot of any Encloſure by going about the ſame, if your Hedge goes up a Hill, you muſt protract the Horizontal Line of that Hill, and ſet down the true meaſure of the Hedge upon that Line ſo protracted: Likewiſe, when you have reduced your Plot into Trapeziums and Triangles, and find the baſe Lines thereof to go over Hills and Dales, cauſe two men to go and meaſure the length between thoſe two Angles over Hills and Dales; and that true meaſure

measure ſet down upon that Baſe Line that is a Horizontal one; and ſo muſt you do had you never ſo many; for ſhould you plot a Cloſe by going about the ſame (without having regard to the Hills and Dales that are in the middle thereof) and caſt up the Content after the uſual manner, you will find it come far ſhort of the true Quantity thereof; therefore to avoid this Error, cauſe all the Diagonals that you have in your Plot, and all the Perpendiculars, to be meaſured by the Chain over Hills and Dales, and ſet thoſe Numbers down upon their reſpective places, and then caſt up the Area after the uſual manner, and you will have the juſt Quantity thereof.

It will be neceſſary to diſtinguiſh theſe kind of Enclоſures from the reſt in your Plot, by ſhadowing them off with Hills and Dales, and likewiſe to expreſs therein the true Content with ſome Note of Inſtruction concerning the ſame; leſt ſtrangers, not being acquainted therewith, applying your Scale to the Plot, may cauſeleſly tax you with Errors committed.

The End of the Firſt Part.

A

SURE GUIDE

TO THE

PRACTICAL SURVEYOR.

The SECOND PART.

SHEWING

The Menſuration and Plotting of *Streets*, *Lanes*, *Courts* and *Allies*; with the drawing of a GROUND-PLOT of all the *Houſes*, *Churches*, and *Eminent Places* of any *CITY* or *CORPORATION*.

AS ALSO,

The Menſuration of *Roads*, *High-Wayes* and *Rivers*; with the manner of making a MAP of any *County*, the exacteſt way that can be.

The like never extant before.

By *JOHN HOLWELL* Philomat.

LONDON,
Printed by *W. Godbid.* 1678.

A

SURE GUIDE

TO THE

PRACTICAL SURVEYOR.

A SURE GUIDE TO THE PRACTICAL SURVEYOR.

PART 2.

CHAP. I.

How to take the Ground-plot of any City or Corporation by the Semicircle.

FOR the performance of which, it will be neceſſary for the young Surveyor to provide himſelf of a Chain that is 50 foot long, containing 50 Links, and each Link a foot; for all Cities are beſt laid down by a Scale of feet: it will be convenient that he have a Rod that is 5 or 10 foot in length, and to be ſubdivided into feet: This Rod is to take the Off-ſets of the Houſes on both ſides your Chain, as you meaſure along the ſtreets or Lanes. *Example.*

Example.

Let *Fig.* 43. be a part of ſome City, and you are required to take a Ground-plot thereof.

Firſt, Cauſe two men to ſtand, one at B, and the other at F; then placing your Inſtrument at A, laying the Index upon the Diameter, turn it about until through the Sights you eſpie the man at F; then ſcrew your Inſtrument faſt, and direct your Sights to the man at B, and note the degrees cut by the Index, which let be 95 deg. and 30 min. Note this 95 deg. and 30 min. down in your Field-Book, as you did when you meaſured the Lane; then with your Rod meaſure your Off-ſets both the Right and Left, as you did in meaſuring the Lane alſo; which you will find to be to the Right 5 feet; then with your Chain meaſure towards B, and at 6 foot diſtance from A, you will have your Off-ſet to the Left to be 7 feet; note both theſe down in your Field-Book or Eye-draught, which is beſt to repreſent the thing; then meaſuring on toward B, you will find that at 47 feet diſtance from A, you will have a Street both to the Right and Left, and the Off-ſet to the Right will be 10 foot, and to the Left 6; note theſe down in your Field-Book or Eye-draught; then ſtill meaſuring toward B, you will find that at 90 foot diſtance from A, you will have an Off-ſet to the Left that is 5 foot; note this down in your Field-Book, and at the ſame time your Off-ſet to the Right will be 11 foot; note this down alſo; then come to B, where one of your men ſtood, and by meaſuring with your Chain, you will find the diſtance between A and B to be 100 foot; then placing your Inſtrument at B (cauſing the man that

that ſtood at F, to ſtand at A, ſo ſoon as you took your Inſtrument up from A) laying your Index upon the Diameter, turn your Inſtrument about until you through the Sights eſpie the man at A; there make your Inſtrument faſt, and cauſe the man that ſtood at B, to go and ſtand at C; then direct your Sights to C, and note the degrees cut by the Index, which let be 140 deg. then with your Rod meaſure the Off ſets both to the right and left, and you will find that to the right it is 11 foot, and to the left 8 foot; then cauſe your men to meaſure towards C, in as direct a Line as they can, and at 61 foot diſtance from B, you have a Street both to the right and left; then meaſure the Off-ſets, and you will find it will be 9 foot on both ſides the way, *viz.* to the right and left, at 120 foot diſtance from B, the Off-ſet to the left will be found to be 8 foot, and at 127 foot diſtance from B, the Off-ſet to the right is 8 foot alſo; then you will find you are come to C; then cauſe a man to go and ſtand at B, and another to ſtand at D, place your Inſtrument at C, and lay the Index thereof upon the Diameter, turning it about till through the Sights you eſpie the man at B; there ſcrew your Inſtrument faſt; then direct your Sights to the man at D, and the Index will be found to cut 100 deg. and if you meaſure with your Rod the Off-ſet to the right at the ſame time, it will be found to be 8 foot; then meaſure with your Chain towards D, and at 8 foot diſtance from C, the Off-ſet to the left will be found to be 9 foot; then meaſure on with your Chain, and you will find that at 64 foot diſtance from C, the Off-ſet to the left is 4 foot; at 75 foot the diſtance of C D, the Off-ſet to the right is 12 foot; then place your Inſtrument at D, and cauſe a man to ſtand at C, and

another at E; and laying the Index of the Inſtrument upon the Diameter, turn it about till through the Sights you eſpie the man at C; there make your Inſtrument faſt; then direct your Sights unto the man at E, and you will find that the Index will cut 100 deg. then with your Rod meaſure the Off-ſet to the right, and it will be found to be 9 foot, and the Off-ſet to the left 11 foot; then with your Chain meaſure towards E, and at 41 foot diſtance from D you will have a Street to the right and left; then meaſuring on towards E, you will find that at 92 foot diſtance from D you will have an Off-ſet to the Right of 5 foot, and the whole diſtance between D and E will be found to be 100 foot; then placing your Inſtrument at E, cauſe a man to ſtand at D, and another at F, and lay the Index upon the Diameter, and turn your Inſtrument about you till eſpie the man at D; there make faſt your Inſtrument, and direct your Sights to F, and note the degrees cut by the Index, which will be found to be 210 deg. then with your Rod meaſure the Off-ſet to the Right, and it will be found to be 7 foot; then with your Chain meaſure towards F, and at 9 foot diſtance from E, you will have a Street both to the Right and Left; the Off-ſet at the ſame time will be found to be to the Right 7 foot, and to the Left 12 foot; ſtill meaſuring towards F, you will find that at 70 foot diſtance from E, your laſt Station, you will find the Off-ſet to the Left to be 7 foot, and the Off-ſet to the Right to be 7 foot, the whole diſtance between E and F is 81 foot; then placing your Inſtrument at F, cauſe a man to ſtand at A, and another to ſtand at E, the place where you laſt had a Station; then laying your Index upon the Diameter of your Inſtrument, turn the ſame about until through the

Sights

Sights you eſpie the man at E; there make your Inſtrument faſt, and direct your Sights to the man that ſtands at A, and you will find the Index will cut 74 deg. and 30 min. then with your Chain meaſure towards A, and at 8 foot diſtance from F the Off-ſet to the Right will be found to be 5 foot, and to the Left 7 foot; then meaſuring on towards A, at 67 foot diſtance from F you will have a Street both to the Right and Left; and ſtill meaſuring on towards A, at 123 foot diſtance from F, the Off-ſet to the Right is 4 foot, and to the Left 5 foot, and the whole diſtance between F and A is 129 foot; then have you done with the Obſervations in the High Streets.

☞ Note, You are to ſet down all your Obſervations as you go along in your Field-Book or Eye-draught, which is beſt. You may make an Eye-draught thus; Firſt go along the place that you intend to take a Plot of, and draw Lines to imitate the ſame, with croſs Streets if there be any, noting your Stations therein by this Mark ⊙; ſetting at every Station the Angles obſerved, and the Off-ſet on either ſide the Line, as you find it to be when you take them, and the length of the Lines between Station and Station, and by this means when you come to protract your Work, you will have a repreſentation of all the work that you have taken; but if you ſet down all your Obſervations in your Field-Book, it will be neceſſary to ſet them down in manner and form following.

The Table of Observations taken when you went about the High Streets.

Station.	Angles d.	m.	Dist. Feet.		Off-sets. R. Feet	L. Feet
1 ⊙ A	95	30			5	00
at ——			6	from A	00	7
at ——			47	from A		
——			——	a Street R. & L.	10	6
at ——			92	from A	0	5
at ——			100	from A	12	00
2 ⊙ B	140	00	100	from A	11	8
at ——			61	from B a Street		
——			——	to the R. & L.	9	9
at ——			120	from B	0	8
at ——			127	from B	8	00
3 ⊙ C	100	00	127½	from B	8	00
at ——			8	from C	00	9
at ——	00	00	64	from C	00	4
at ——			75	from C	12	00
4 ⊙ D	100	00	75	from C	9	11
at ——			41	from D a Street		
——				to the R. & L.	5	00
at ——			92	from D	00	7
5 ⊙ E	210	00	100	from D		
at ——			9	a Street R. & L.	7	12
at ——			70	from E	7	7
6 ⊙ F	74	30	83	from E	5	
at ——			8	from F		7
at ——			67	a Street R. & L		
at ——	00	00	123	from F	4	5

Having

Having thus taken your High Streets, you may in the like manner proceed with the other ſmall Streets and Lanes, with the ſeveral Boughs and Breaches, noting down in your Eye-draught or Field-Book againſt every one of them the Off-ſets to the Right or Left according as you find them on either ſide of your Chain.

Note, That when you take your main Streets, it will be convenient as often as you come againſt any croſs Street to take a Sight down it, and note the place or mark that you take to, and the place of ſtanding when you take your Sight to any Mark that is in the croſs Streets in your Eye-draught with this Mark ⊙, and ſo by that means you will know where to place your Inſtrument when you begin to take the croſs Streets; your high Streets and your croſs Streets being thus taken, in the next place you are to take the meaſure of the Houſes to the Front, and likewiſe the depths of every one of them, and with your Rod or Bevil take the Plots of your Courts and Allies, firſt by drawing an Eye-draught of them, ſetting upon every Break or Return thereof the meaſure you took with your Rod; and in ſo doing, you will find it no hard matter to protract the ſame after you have protracted both ſides of every Street; for you will have the Repreſentation of every Court and Ally in its proper place.

CHAP. II.

How to protract or lay down any Observation taken according to the Directions of the last Chapter

FIrst, having provided your self of good Paper or Velam to protract it upon, draw a Line at length to represent the Line A F in *Fig.* 43. then laying the Center of your Protractor upon the Point, turn your Protractor about until the Line A B thereof lie directly on the Line A F; then finding by your Field-Book or Eye-draught that the Angle observed at A, was 95 deg. and 30 min. against 95 deg. 30 min. of your Protractor make a Mark, and draw the Line A B at length; then finding also that the length of A B was 100 foot, take 100 from off your Scale of equal parts, and place it from A to B; then placing the Center of your Protractor on the point B, turn your Protractor about until the Line A B thereof lie directly upon the Line A B last drawn; then finding that the Angle observed at B was 140 deg. against 140 of your Protractor make a Mark with your protracting-pin, and draw the Line B C at length; then finding also that the length of B C was 127 foot, take 127 from off your Scale of equal parts, and place it from B to C; then laying the Center of your Protractor upon the point C, turn it about until the Line A B thereof

thereof lie directly on the Line B C laſt drawn; then finding by your Field-Book or Eye-draught that the Angle obſerved at C was 100 deg. againſt 100 deg. with your protracting-pin make a Mark, and draw the Line C D at length; then finding that the length of the Line was 75 foot, take 75 foot from off your Scale of equal parts, and place it from C to D; then lay the Center of your Protractor upon D, and turn it about until the Line A B thereof lie directly on the Line D C laſt drawn; then finding by your Field-Book or Eye-draught that at D you did obſerve an Angle of 100 deg. therefore againſt 100 deg. of your Protractor, with your protracting-pin make a Mark, and draw the Line D E at length; then finding alſo that the length of your Line D E was 100 foot, take 100 from off your Scale of equal parts, and place it from D to E; then remove your Protractor, and lay the Center thereof upon the point E, and finding by your Field-Book the Angle obſerved at E was 210 deg. againſt 210 deg. of your Protractor make a Mark with your protracting-pin, and draw the Line E F at length; then finding that the length of E F was 83 foot, take 83 from off your Scale of equal parts, and place it from E to F; then placing the Center of your Protractor upon the point F, turn it about until the Line A B thereof lie directly on the Line E F laſt drawn; then finding by your Field-Book that the Angle obſerved at F was 74 deg. and 30 min. againſt the ſame deg. and min. of your Protractor make a Mark with your protracting-pin, and draw the Line F A; which if you have protracted right, will fall to be exactly 129 foot; then have you protracted your principal Lines. Now begin to protract your Offſets, thus.

First, finding by your Field-Book or Eye-draught that at your first ſtation A, the Off-ſet to the Right was 5 foot, take 5 foot from off your Scale of equal parts, and place it from A to *a*; then finding alſo that at 6 foot diſtance from A, the Off-ſet to the Left was 7 foot, take 7 from off the ſame Scale of equal parts, that you protracted your principal Lines from, and place it from A to *o*; then finding that at 47 foot diſtance from A, the Off-ſet to the Right was 10 foot, take 10 from off your Scale of equal parts, and place it from *e* on the Line A B, to 2, and draw the Line *a* 2 at length; then finding alſo that at the ſame time the Off-ſet to the Left was 6 foot, take 6 from off your Scale, and ſetting one point of your Compaſſes in *e*, on the Line A B, with the other make a Mark on the Left hand of the Line A B, and draw a Line from *o* to this laſt Mark made; then becauſe you find by your Field-Book that at the laſt Off-ſets there was a Street both to the Right and Left, you muſt make a Mark to ſignifie the ſame; then finding by your Field-Book that at 92 foot diſtance from A, the Off-ſet to the Left was 5 foot, theſe 5 foot take off from off your Scale of equal parts, & ſetting one foot of your Compaſſes in the point *f*, with the other make a ſmall Mark on the Left hand of the Line A B, and draw a Line from the Street to this Mark, the Off-ſet to the Right at the ſame time was 12 foot; take this 12 foot from off your Scale, and ſetting one foot of your Compaſſes in the point, with the other make a Mark on the right ſide of the Line A B, and draw a Line from the Street to this Mark laſt made; then finding that at your ſtation B, you had the Off-ſet to the Right 11 foot, take 11 from off your Scale of equal parts, ſetting one foot of your Compaſſes in the point

with the other make a Mark on the right hand ſide of the Line B C; the Off-ſet at the ſame time to the Left was 8 foot, take 8 foot from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point B, with the other make a Mark on the Left ſide of the Line B C; then finding by your Field-Book or Eye-draught that at 61 foot, the Off-ſet to the Right and Left was 9 foot, take 9 from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point *p*, with the other make a Mark on both ſides the Line; then draw Lines on both ſides of the Line B C, from the Marks made on both ſides of the Line at B, to the Marks laſt made; and becauſe there is a Street at the Off-ſet laſt taken, make a Mark to ſignifie the ſame at 120 foot diſtance from B, the Off-ſet to the Left was 8 foot; take 8 from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point V, with the other make a Mark on the Left ſide of the Line B C; and draw a Line from the Street on the left ſide of the Line B C to the laſt Mark made; then at your ſtation C, you had an Off-ſet to the Right of 8 foot alſo; take 8 from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point C, with the other make a Mark on the Right ſide of the Line B C, and draw a Line from the Mark that you made for the Street on the Right ſide of the Line B C, through the laſt Mark made at length; then finding by your Field-Book or Eye-draught, that when you had obſerved the Angle at C, you had an Off-ſet to the Right of 8 foot, take 8 from off your Scale of equal parts, and ſetting one foot of your Compaſſes in the point C, with the other make a Mark on the Right ſide of the Line C D; you likewiſe find at 8 foot diſtance from C, you had

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an Off-set to the Left of 9 foot; therefore take 9 from your Scale of equal parts, and placing one foot of your Compasses in the point X, with the other make a Mark on the Left side of the Line C D; you will likewise find by your Field-Book or Eye-draught that at 64 foot distance from C, you had an Off-set to the Left 4 foot; take 4 from off your Scale of equal parts, and setting one foot of your Compasses in the point Z, with the other make a Mark on the left side of the Line C D, and draw a Line from the Mark that was made on the Left side of the Line C D, at X, to the Mark last made; then by your Field-Book you will find that at your station D, the Off-set to the Right was 12 foot; take 12 foot from off your Scale, and setting one foot of your Compasses in the point D, with the other make a Mark on the Right side of the Line C D, and draw a Line from the Mark that was made on the right side of the Line C D, *viz.* at C to the Mark last made; then finding that when you observed your Angle at D, you had the Off-set to the Right 9 foot, and to the Left 11 foot, take 9 from off your Scale of equal parts, and placing one foot of your Compasses in the point D, with the other make a Mark on the right side of the Line D E, and take 11 from the same Scale, setting one foot as before in D, make a Mark on the left side of the Line DE with the other; by your Field-Book you will find that at 41 foot distance from D you had a Street both to the Right and Left; make a Mark to signifie the same: Likewise you will by your Field-Book find that at 92 foot distance from D, you had an Off-set to the Right of 5 foot; take 5 from off your Scale of equal parts, and setting one foot of your Compasses in the point Y, with the other make a Mark on the right side of the Line

D E,

DE, and draw a Line from the Mark made at D, o the right ſide of the Line DE, to the Mark ſt made at length, until it doth interſect the ine that was drawn on the right ſide of the ine CD: you will find by your Field-Book that your Station E, the Off-ſet to the Leſt was 7 foot; his 7 foot take from off your Scale of equal parts, nd ſetting one foot of your Compaſſes in the point , with the other make a Mark on the left ſide of the ine DE, and draw a Line from the Mark made on e left ſide of the Line DE, at D; to this Mark laſt rawn at length; you will find by your Field-Book at at 9 foot diſtance from E towards F, you had an ff-ſet to the Right 7 foot, and to the Left 12 foot; erefore take 7 foot from your Scale of equal parts, d placing one foot of your Compaſſes in the point , with the other make a Mark on the right ſide of e Line F E; and likewiſe take 12 from the ſame ale, and placing one foot of your Compaſſes as be-re, in the point H, with the other make a Mark on e left ſide of the Line E F, and draw a Line from the ark that was made on the left ſide of the Line D E, Y, to this Mark laſt made; then becauſe theſe two t Off-ſets were the Corners of two Streets, make a ark to ſignifie the ſame; at 70 foot diſtance from E wards F, the Off-ſet to the Right was 7 foot, and the Leſt 7 foot alſo, take 7 from off your Scale of al parts, and placing one foot of your Compaſſes the point K, with the other make a Mark on each e of the Line E F, and draw a Line from the Mark at was made on the right ſide of the Line E F, at H, the Mark that was laſt made on the right ſide of the ne E F at K; and draw a Line likewiſe from the ark that was made on the left ſide of the Line E F,

at

at H, to the Mark that was laſt made on the left ſide of the Line E F, at K; then by your Field-Book you will find that at your Station F, your Off-ſet to the Right was 5 foot; take 5 from your Scale of equal parts, and placing one foot of your Compaſſes in the point F, with the other make a Mark on the right ſide of the Line F A, and at 8 foot diſtance from F, you had alſo the Off-ſet to the Left 7 foot; take 7 from off your Scale of equal parts, and placing one foot of your Compaſſes in the point N, with the other make a Mark on the left ſide of the Line F A. At 67 foot diſtance from F, you had a Street to the Right and Left; therefore make a Mark to ſignifie the ſame; at 123 foot diſtance from F, towards A (by your Field-Book you will find) you had an Off-ſet to the Right 4 foot; take 4 from off your Scale of equal parts, and placing one foot of your Compaſſes in the point R, with the other make a Mark on the right ſide of the Line F A, and draw a Line from the Mark that was made on the right ſide of the Line F A, at the point N, to the point that was laſt made, ſo that the Line which you draw may interſect the Line which is drawn on the right ſide of the Line E F, and the Line that is drawn on the right ſide of the Line A B; then at the ſame time you had an Off-ſet to the Left, of 5 foot; take 5 likewiſe from your Scale of equal parts, and placing one foot of your Compaſſes in the point R, with the other make a Mark on the left ſide of the Line F A, and draw a Line from the Mark that was made on the left ſide of the Line F A, at N, to the Mark that was laſt made on the left ſide of the ſame Line at R; then have you made an end of protracting your High Streets: In the ſame manner you muſt protract your by-Lanes and Streets. You muſt like-

wiſe

wiſe deal ſo with all Allies that are thorough-Fares.

Your Streets and Lanes being thus protracted, you may proceed to the protracting and laying down the Ground-plot of the ſeveral Houſes thereon; for the doing of which, it will be convenient that you have a ſmall Scale that is actually divided into 50 equal parts in an Inch; then laying your Scale along by the ſide of the Line *o e* in *Fig.* 43, and againſt the meaſured breadth of each Houſe, with your protracting-pin make a Mark or Marks; then lay the edge of your ſmall Scale along the ſide of the Line *e* S, and againſt the meaſure of each ſeveral Houſe that is thereon, with your protracting-pin make a Mark; then lay your ſmall Scale along the ſide of the Line S Q, and finding by your Eye-draught that there is a Court or Yard, firſt make a Mark againſt the meaſure of the ſeveral Houſes until you come to the Court or Yard, and then mark out the breadth of the Entrance thereof as you did the breadth of the Houſes; and likewiſe make Marks againſt the breadth of each Houſe on the other ſide of the Court alſo; then laying your ſmall Ruler or Scale along the ſide of the Line Q O, againſt the meaſure of the breadth of each ſeveral Houſe, with your protracting-pin make a Mark. Having thus laid down the breadth of each ſeveral Houſe, the next thing you do lay down the depth of each Houſe, and draw Lines in the ſame manner as you ſee thoſe in *Fig.* 43, and ſhadow them alſo as you ſee, that they may repreſent the Ground-plot of a Houſe.

When you come to protract the Court, lay your Eye-draught before you, and draw the bending and turning according to diſcretion, laying down the meaſure of each ſeveral Houſe that is therein, as you did in the Streets; you muſt alſo protract the Yards

Yards or Gardens that are behind the Houſes; with the turnings and windings thereof accordingly as you take them.

☞ Note, That when you take the Ground-plot of any Church, you muſt be very exact in taking the Buttreſſes, and the Steeple, and every one of the Pillars, and protract or lay them down in the ſame form and meaſure as you found them ſtanding, and ſhadow them very deep, that they may be known to be Churches.

You muſt likewiſe uſe the like exactneſs in meaſuring and protracting Halls, Inns of Court, Colledges, and all eminent Houſes, and ſhadow them accordingly.

In this mannner is the City of *London* ſurveyed by *John Ogilby*, Eſquire, I my ſelf being concerned in Meaſuring and Plotting of above 200 Acres thereof. This is the beſt and moſt accurate way that I can find out in all my Practice; one day's experience will confirm any one in my Opinion.

Thoſe that are minded to draw the Map of any Town, City or Corporation, only with the Uprights of the Houſes, will have no need to meaſure either the Houſe, Courts or Allies thereof.

CHAP

CHAP. III.

The Description of the Wheel by which the Roads are measured.

THis Wheel doth consist of several parts: As first, There is a Wheel which contains 8 foot 3 inches about, it being shoed with Iron, to prevent wearing; at the Axletree of this Wheel there is a Starr or a Nut, whose use is to turn a Rod of Iron about when the Wheel moves round; at the upper end of this Rod there is a Way-wiser, which Way-wiser is moved by the Rod, when the Wheel goes about: This Way-wiser hath in it but two Wheels, one of them having 80 Teeth, and the other 81; so that means, when one Wheel hath gone about, the other wants 1 of going about; these two Wheels are so placed, that the Worm that is put into the upper part of the Rod, doth go in the Teeth of both these Wheels. On the upper part of this Way-wiser there is a Plate that moves round once in a Furlong, viz. when the Half-Pole-Wheel hath gone about 80 times, there is a Hand that moves the contrary way about, once in 10 Mile; by which means it is easie to know how many Miles, Furlongs and Poles you go at any time, by driving the Wheel before you.

CHAP.

CHAP. IV.

How to take the Plot of any Roads or High-Ways by the Wheel and Semicircle,

IT will be convenient that the Surveyor have a Field-Book for that purpose (the fitteſt is in a long *Folio* like a narrow Shop-Book) with a Line near the Right Hand of every Page, leaving a Column towards the Right Hand about an Inch in breadth, and at the Head of this Column write M for Miles, and F for Furlongs, and P for Poles.

Now at the beginning of your Journey, at the top of one of your Pages write the Name of the Place where you begin your Journey, and likewiſe make a Mark to repreſent your firſt Station; which let be ſuch an one as this Mark ⊙; then ſetting down your Inſtrument, turn it about until the Needle hang directly over the Meridian-Line in the Chart; then direct your Sights ſo far as you can ſee, and note the degree down in your Field-Book which are cut by your Index (that is) how many degrees it is from the North or South, towards the Eaſt or Weſt; which call a Bearing; then when you come to that place (letting one drive the Wheel before him) write down the diſtance in Miles, Furlongs or Poles, in that Column that is on the Right Hand of every Page; then ſetting down your Inſtrument, turn it about until the Needle hang over the Meridian of the Chart; then make it faſt, and direct your Sights forwards ſo far ti

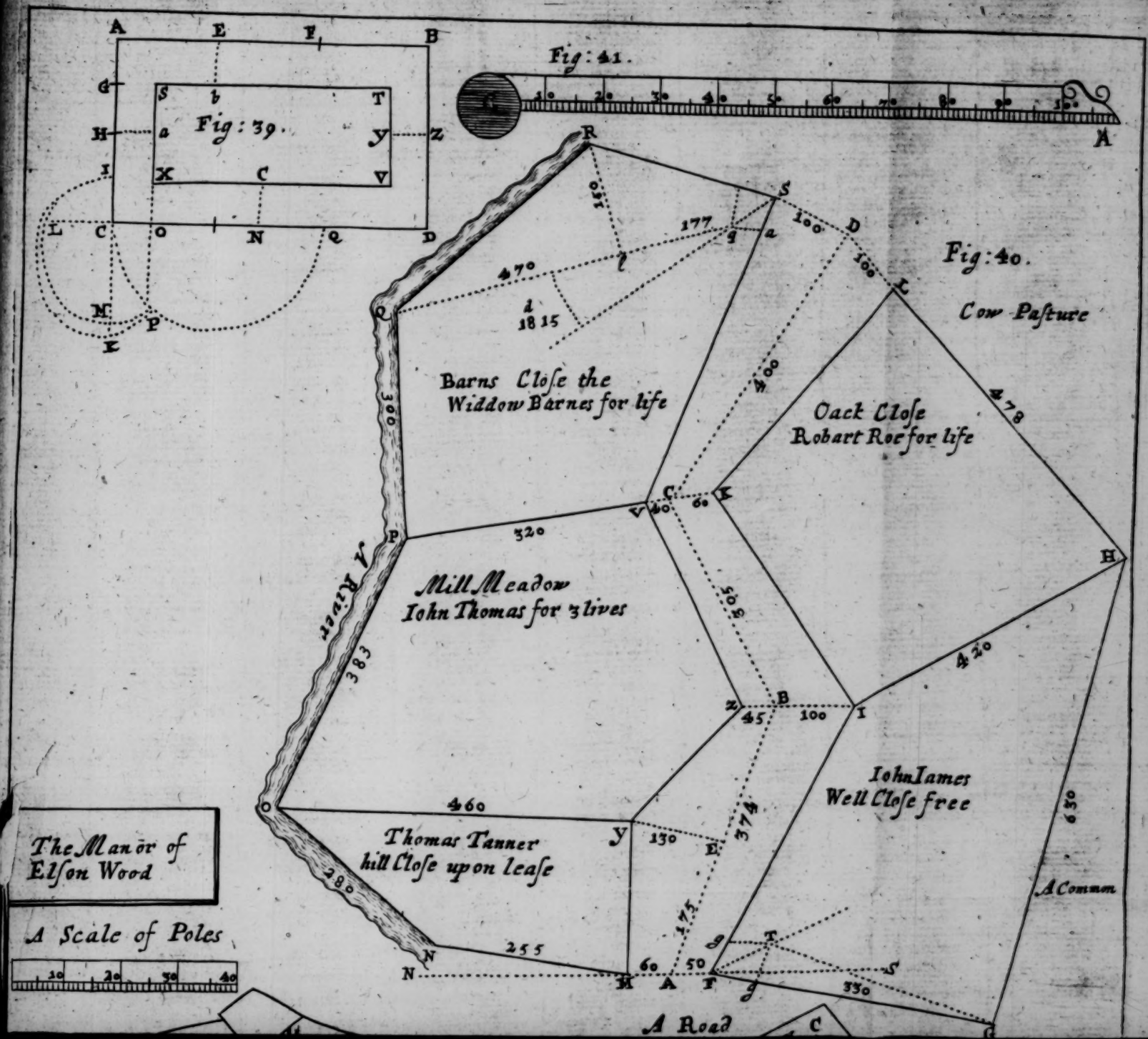
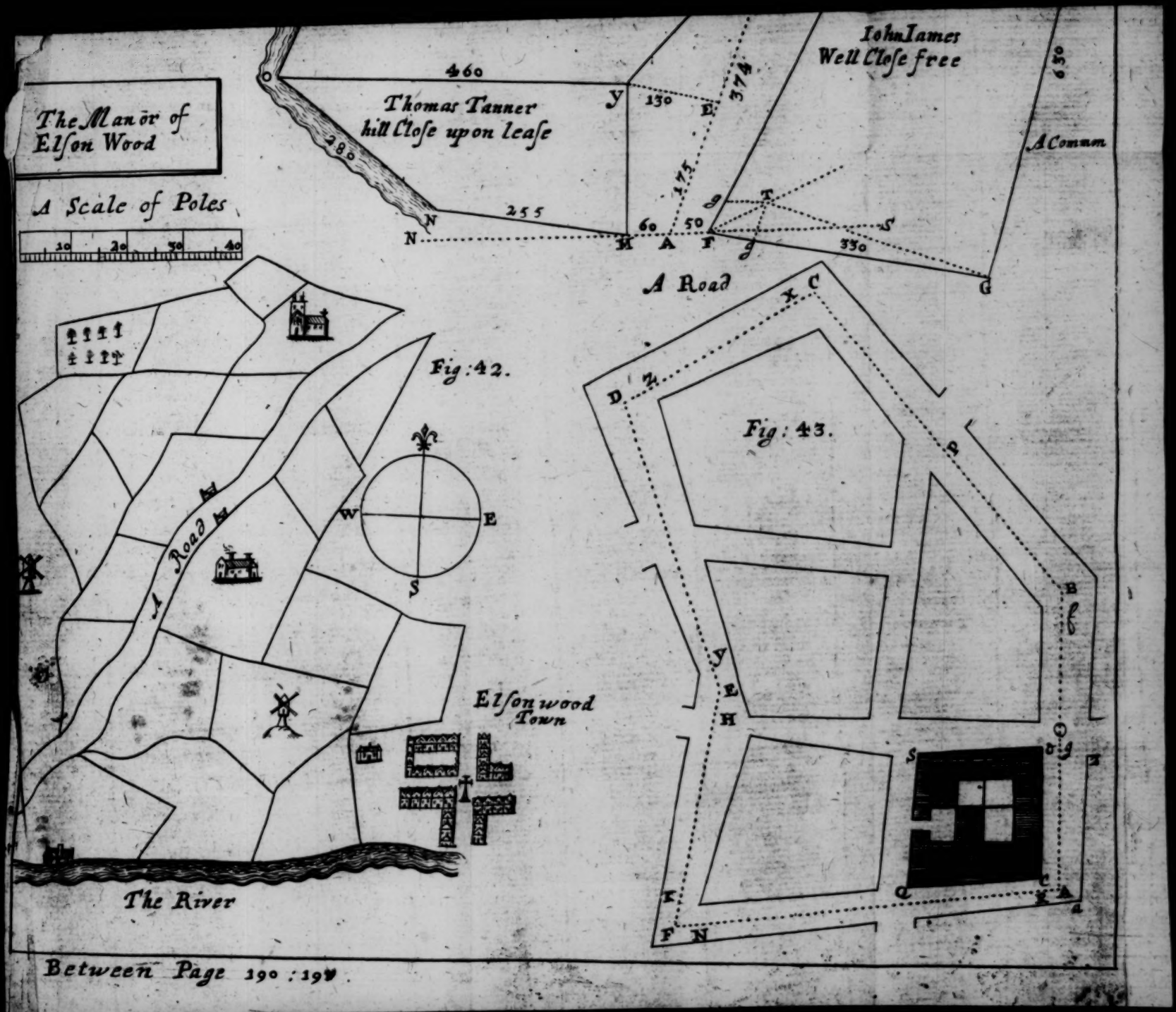


Fig: 39.
Fig: 41.
Fig: 40.
Cow Pasture
Barns Close the Widdow Barnes for life
Oack Close Robart Roe for life
Mill Meadow Iohn Thomas for 3 lives
Iohn Iames Well Close free
Thomas Tanner hill Close upon lease
A River
A Common
A Road
The Manor of Elson Wood
A Scale of Poles



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till you can ſee another Turning or Bend, and note down the degrees of bearing, and which way; and when you come to that place, ſet down the diſtance from the laſt Station to this; in this manner proceed till you come to your Journeys end.

In your meaſuring along from Station to Station, you are to obſerve, firſt, what By-Lanes or Roads you meet with in your way; whether they be to the Right Hand or to the Left, and to what places they go, and how they incline, whether forwards or backwards, or whether they be at right Angles with the Road you are meaſuring, and note it down in your Field-Book with two Lines, thus =; on the Right or Left ſide of the Line; that is, if the Road or Lane be on the Right hand, then place it on the Right Hand of the Line; but if the Road be on the Left Hand, then place it on the Left ſide of the Line; if the Road doth incline forwards, then make it on either ſide of the Lane or Road, thus; ⊬ if the Road or Lane incline backwards, then mark it thus, ⊰ if it be at right Angles with the Road you meaſure, then mark it down thus ⊨; Likewiſe ſet down at what diſtance from your Stations the Lanes or Roads do turn out from the Road you meaſure, thus, At ſo many Furlongs and Poles a Road to the Right or Left to ſuch a Place.

Likewiſe, when you paſs over any Bridge, note it down in your Field-Book, with the diſtance from the laſt Station, as alſo the Name of the Water that runs under it, and from whence it hath its Riſe, and where it doth empty it ſelf; ſo muſt you do when you paſs over any Ford or Rill where there is no Bridge.

Note down alſo when you aſcend a Hill, and when

you come to the top thereof, and when you deſcend the ſame, and when you come to the bottom thereof.

As alſo when you paſs through any Town or Village, note at how many Miles, Furlongs and Poles you enter the ſame, and at how many Miles, Furlongs and Poles you leave it.

You muſt likewiſe take notice whether the Houſes in the Town or Village be cloſe or ſcattering, or whether you find the Houſes to be on the Right or Left ſide firſt, or whether you enter the Town or Village with Houſes on both ſides.

Note down alſo the Mills, whether Water-Mills, or Wind-Mills that are on the Road, and the diſtance from your laſt ſtation; if there be any lone-Churches on the Road, note them down with their Names, and whether they be Towers or Spires, with their diſtance from your laſt ſtation.

☞ Note, That when you paſs through any Town or Village, you muſt enquire the right Name thereof, and write it down; and if it be a Market-Town, note the Days on which they keep their Markets, and what Days they hold their Fairs, and how it is governed, whether by Mayors or Bailiffs, with the Number of Conſtables and other Officers.

In your meaſuring along the Road, if you ſee any Churches, Manſion-Houſes, Beacons, Wind-Mills, Towns, Villages, or any other thing remarkable, you muſt take a bearing to it, noting down in your Field-Book the Name of the place, and how it doth bear, and at what diſtance from your laſt ſtation you took this Bearing.

Then in your meaſuring forward, at as great a diſtance as you can, take another Bearing to thoſe places you took laſt, provided you may but ſee them, and note

note the Name of the places, and how they bear, and at what distance from your last station, down in your Field-Book, as you did before.

If you do but follow this Method, you will find it no hard matter to describe the Roads of any Countrey; this was the Method that both my self and others used, who were employed in measuring the Roads for *John Ogilby* Esq; His Majesties Cosmographer.

CHAP. V.

Containing an Explanation of the Rules in the foregoing Chapter, by way of Example, in a Road between London *and* High-Gate, *by me actually measured for that end, beginning at the Pound in* St. Johns-Street.

LEt *Fig.* 44 be the Road, and let A thereon be the Pound at the upper end of St. *John's-Street*.

First, Place your Instrument at A, letting the Needle hang directly on the Meridian of the Chart; then direct your Sights to the man that stands at B (for you must let a man go as far as you can well see, and then by some known Sign cause him to stand) and note the degrees (cut by the Index, which let be NW. 25 deg.) down in your Field-Book; then cause one to drive the Wheel from the place where your

Inſtrument ſtood at A, to the place where the man ſtood at B, and note this down in your Field-Book alſo.

But note, That at your firſt Station A, you muſt ſet no meaſure; but the laſt diſtance meaſured you muſt ſet againſt the ſecond Station B, and note down the Number of your Stations in your Field-Book, with this Mark ☉; Note down your firſt Station in this manner 1 ⊙.

Then placing your Inſtrument at B, your ſecond Station, turning it about until the Needle hang directly over the Meridian-Line of the Chart; then direct your Sights to the man at C, and note the bearing down in your Field-Book thus; The bearing of my 2 ⊙ was N E 32 deg. then cauſe your man to drive the Wheel from your Station B, to the man at C, and you will find the diſtance between the two Stations B and C, to be 22 Poles; which ſet down in your Field-Book under Poles, againſt the third Station; then bringing your Inſtrument to C, your third Station, and turn it about until you find the Needle hang over the Meridian in the Chart; then direct your Sights to the man at D, and note down the bearing in your Field-Book; which let be thus, 3 ⊙ N W. 9 deg. then cauſe the man with the Wheel, to meaſure the diſtance between the place where the Inſtrument is, and the man at B, which you will find to be 34 Poles; theſe 34 Poles ſet down in your Field-Book againſt the 4th. Station, under Poles; then bringing your Inſtrument to D, cauſe a man to go and ſtand at E; and your Inſtrument being placed at D, with the Needle hanging directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man at E, and note the bearing down in your

Field-

Field-Book, as before, thus, 4 ⊙ N E. 7 deg. then cauſe the man with the Wheel to meaſure the diſtance between ⊙ and E, which you will find to be 24 poles; note this down in your Field-Book againſt the 5th. Station, under Poles; you will find alſo that at your 4th Station you had a Houſe to the Left in the Road; note this down in your Field-Book alſo; then bring your Inſtrument to E, your 5th. Station, and there place it with the Needle hanging over the Meridian-Line of the Chart, as you did before; then having cauſed a man to ſtand as far as you can ſee the Road go ſtraight, *viz.* at F, to him direct your Sights, and note down the bearing as before, in your Field-Book, which you will find to be N W 6 deg. and 30 min. note it down thus, 5 ⊙ N W 6 deg. 30 min. then cauſe the man with the Wheel to meaſure towards F, and at 3 Poles diſtance from E you will have a Houſe to the Left; and at 13 Poles diſtance from E you will have a Bridge over the New River, and ſo begin to enter *Iſlington*, with Houſes to the Right Hand, and at the man at F, your 6th. Station, it will be one Furlong and 16 Poles; this one Furlong and 16 Poles ſet down in your Field-Book againſt F, your 6th Station, under Furlongs and Poles; then placing your Inſtrument F, with the Needle as before hanging over the Meridian-Line, direct your Sights to the man at G, and note down the bearing in your Field-Book, which will be N W 5 deg. note this down thus 6 ⊙ N W 5 deg. then cauſe the man with the Wheel to meaſure towards G, and at 5 Poles diſtance from F you will have a Road to the Right hand of you, which goes to *Old-Street*; note this down in your Field-Book with this Mark ⋚ on the Right Hand of the Line a little bending behind you, becauſe the

Road did ſo; at the ſame time you begin to have Houſes on the Left hand alſo; note that down in your Field-Book, thus, Houſes to the Left; at 5 Poles diſtance from F, you find that the man at G will be 19 Poles diſtance from F; this 19 Poles ſet down in your Field-Book againſt the 7th. Station G; then placing your Inſtrument at G, fix it in all reſpects as you did at F; then cauſe a man to go and ſtand at H, and direct your Sights to that place, and note down the Bearing as you did before, which you will find to be N E 29 deg. and 30 min; this note down in your Field-Book thus, 7 ⊙ N E 29 deg. 30 min. then cauſe the man with the Wheel to meaſure towards the man at H, and at 17 poles diſtance from G, you will have a Road to the Left Hand; this Road goes the Back-way to *High-Gate*; and becauſe the Road doth bend a little forwards, you muſt therefore note it down in your Field-Book on the Left Hand of the Line with two Lines, thus ⫤; and alſo write down to what place the Road goes; & 1 furlong 16 pole diſtance from G, you will leave the Houſes to the Right hand; therefore ſet down the 1 Furlong 16 Pole under the Furlongs and Poles; and againſt it in the large Column towards the left hand, write down *Leave Houſes to the Left*: at 1 Furlong 38 Pole you will paſs over a Bridge, and will have a Pound in the Road, and a Road bending forward alſo; this Road goes to *Kings-Land* and the Back-ſide of *Iſlington*: firſt, note down the Bridge, then the Pound, and then the Road with two Lines thus ⫤ on the right hand of the Line, with the direction to what Place it goes, and ſet down the Furlong and Poles againſt them all three; then meaſuring to H, you will find that the Diſtance from G to H will be 2 Furlongs and 10 Poles; theſe Furlongs

longs and Poles note down in your Field-Book againſt H your 8th Station; then placing your Inſtrument at H, turn it about till you find the Needle hanging directly over the Meridian-Line in the Chart; then cauſe a man to go and ſtand at I, and direct your Sights to that place, and note down the Bearing in your Field-Book, which will be found to be N E 16 deg. note theſe degrees down thus; 8 ⊙ N E 16 deg. then cauſe the man with the Wheel to meaſure towards the man at I, and at 12 Poles diſtance from H, you will begin to have Houſes to the Right hand of you, which note down in your Field-Book, thus; ſetting down 12 Pole under the Poles; and againſt it write, *Enter Houſes to the Right cloſe*; the diſtance between H and I will be found to be 16 Poles, this Poles note down in your Field-Book againſt your 9th Station; then placing your Inſtrument at I, turn it about till you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and cauſe a man to go and ſtand at K, and then direct your Sights to that place, and note the Bearing down in your Field-Book, which will be found to be N E 9 degrees, which 9 degrees note thus; 9 ⊙ 9 deg. then cauſe the man to meaſure the diſtance between I and K, which you will find to be 17 Poles; this 17 Pole muſt be noted down in your Field-Book againſt your 10th Station; then place your Inſtrument at K, in all reſpects as you did at I, and making it faſt, cauſe a man to go and ſtand at L, and direct your Sights to that place, noting the Bearing of the Road down in your Field-Book, which will be found to be N E 17 deg. 30 min. note this down in this manner 10 ⊙ N E 17 deg. 30 min. then cauſe a man to go and meaſure the diſtance between K and L, which will be found to

21 Pole; this 21 Pole note down in your Field-Book againſt your 11th Station; then bring your Inſtrument and place it at L, and turning it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt; then cauſe a man to ſtand at M, and directing your Sights to that place, note the degrees down in your Field-Book as before; the bearing will be found to be N W 0 deg. 30 min. note this down thus; 11 ⊙ N W 0 deg. 30 min. At this your Station you will have *Iſlington*-Church to the Right in the Road, with a Tower-Steeple; this note down in your Field-Book, with the manner of the Steeple; then cauſe the man with the Wheel to go and meaſure towards M, and at 21 Pole diſtance from L, you will find a Road to the Right to *Kings-Land*: At 1 Furlong 18 Poles diſtance from L, your 11th Station, you will have a Wooden Bridge, and a Houſe to the Right, and at the ſame time you leave Houſes to the Left; theſe note down in your Field-Book, and againſt them note down the 1 Furlong and 18 Pole; then meaſuring on towards the man at M: at 1 Furlong 33 Poles you begin to have Houſes on the Left Hand of the Road; theſe note down in your Field-Book thus; *Enter Houſes to the Left at 1 Furlong 33 Poles.* At 2 Furlongs 25 Poles from L, your laſt Station, you will have a Road to the Right to *Cambury*-Houſe, and a Road to the Left to the Back-Road that goes to *High-Gate*; this Road to the Right and Left note down in your Field-Book with two Lines, thus ⫫; and againſt them in the left hand Column, write *The Right to Cambury-Houſe*, and *the Left to the Back-road to* High-Gate; and againſt theſe two Lines in the right hand Column write down the Furlongs and Poles the Roads are diſtant from your laſt Station,

which

which is 2 Furlongs and 33 Poles. At 3 Furlongs 17 Poles distance from L your last Station, you will have a Road to the Left to the Back-Road that goes to *High-Gate*; this note down in your Field-Book with 2 Lines on the left hand the Line, thus; ⫤ and note down in the left hand Column to what place it goes, and in the right hand Column the 3 Furlongs and 17 Poles; then measuring still on towards M, at 3 Furlongs 21 Poles from L, your last station, you will leave Houses to the left; note this down in your Field-Book in the left hand Column thereof, and against it in the right hand Column note down the 3 Furlongs 21 Poles; then measuring to M, your 12th Station, you will find it to be 4 Furlongs 15 Poles from L; this 4 Furlongs 15 Poles note down in your Field-Book against M, your 12th Station; then placing your Instrument at M, cause a man to go as far as you can well see him; then by some Sign cause him to stand, which place call N; turning it about until the Needle doth hang directly over the Meridian-Line; there make it fast, and direct your Sights to the man at N, and note the Bearing (which you will find to be N W 43 deg.) down in your Field-book thus, 12 ⊙ N W 43 deg. At the same time you took this Bearing, you will have a Road to the Right behind you that goes to *Kings-Land*; this Road note down in your Field-book with 2 Lines, in this manner ⫣; on the right side of the Line, and in the left hand Column write to what place it doth go; then cause the man that drives the Wheel to measure forwards towards N, and at 12 Poles distance from M, your last Station, you will begin to have Houses to the left scattering; note this down in your Field-Book also: at 25 Poles distance from M you will have a Conduit to

the

the Right, about half a Furlong from the Road, and at the ſame time you will have *Jack Straw*'s Caſtle to the Right, about 2 Furlongs from the Road; this Conduit and *Jack Straw*'s Caſtle, with their diſtance from the Road, note down in the left hand Column, and againſt them in the right hand Column write down the diſtance from your laſt ſtation; meaſuring ſtill towards N, you will find the diſtance between M and N, to be 1 Furlong 20 Poles; this 1 Furlong 20 Poles note down in your Field-Book againſt your 13 ſtation N; then placing your Inſtrument at N, with the Needle hanging directly over the Meridian-Line in the Chart, make your Inſtrument faſt, and direct your Sights to the man that ſtands at O, and note the bearing (which you will find to be N W 34 deg. and 30 min.) down in your Field-book thus; 13 ⊙ N W 34 deg. 30 min. then cauſe the man with the Wheel to meaſure forwards towards the man at O, and at 19 poles diſtance from N, your laſt Station, you will leave the Houſes to the left ſcattering; note this down in your Field-book, and in the right hand Column thereof note down the diſtance you are from your laſt Station N, meaſuring on ſtill towards O. At 1 furlong 25 poles diſtance from N, your laſt ſtation, you will have a wooden Bridge croſs the Road, note this Bridge down in the left hand Column of your Field-Book, and againſt it in the right hand Column note down the 1 furlong 25 poles; at 1 furlong 26 poles, you will have a Road to the left to *Iſlington*; this Road note down on the left ſide of the Line thus ⫢; and againſt it in the right hand Column, note down the 1 furlong and 26 poles, and in the left hand Column write the place to which the Road doth go, meaſuring on until you come to O,

your

your 14th ſtation, and you will find that to be 2 furlongs, 14 poles; this 2 furlongs 14 poles note down in your Field-book againſt O your 14th ſtation; you will have likewiſe at the ſame time a Houſe both to the Right and Left; this note down alſo in the left hand Column of your Field-book; then placing your Inſtrument at O, turn it about until you make the Needle hang directly over the Meridian-Line of the Chart, there make it faſt; then cauſe a man to go till he find the Road begin to have another Bending, there let him ſtand ſtill; then direct your Sights to the man at P, and note the Bearing (which you will find to be N W 36 degrees) down in your Field-book thus; 14 ⊙ N W. 36 deg. then cauſe the man with the Wheel to meaſure t wards P, and at 17 poles diſtance from O, your laſt ſtation, you will have a Road to the Right, forward to *Hornſey*; this Road note down on the right ſide of the Line thus ⅄; and in the left hand Column note down to what place the Road goes, and in the right hand Column note down 17 poles, the diſtance from your laſt ſtation; meaſuring on towards P, at 1 furlong 12 poles diſtance from O, you will paſs over a Bridge; note this Bridge down in the left hand Column of your Field-book, and againſt it in the right hand Column note down 1 furlong and 12 pole: at 4 furlongs and 14 poles diſtance from O, your laſt ſtation, you will paſs over another Bridge; note this down in the left hand Column of your Field-book alſo, and againſt it in the right hand Column note down 4 furlongs 14 poles; meaſuring towards P, you will find, that at 4 furlongs 20 poles you will have a Road to the left to *Kentiſh-Town*; this Road note down on the left ſide of the Line thus ⅃; and in the left hand Column note down to what place

it

it goes; and againſt it in the right hand Column note down 4 furlong 20 poles: at 5 furlongs diſtance from O, your laſt ſtation, you will have *Hulington*, a Village to the right, about a furlong from the Road; ſet this Village down in the left hand Column, with its computed diſtance from the Road; and againſt it in the right hand Column, note down the 5 furlongs: at 5 furlongs 25 poles diſtance from O, your laſt ſtation, you will have a Houſe both to the right and left; note this down in the left hand Column, and againſt it in the right hand Column, note down the 5 furlongs and 25 poles. At 6 furlongs 22 poles you will find you are come to P, your 15th ſtation; this 6 furlongs and 22 poles note down againſt P. At the ſame time you find *Newington*-Church to bear from you SE 88 deg. then cauſe a man to go to Q, the place where you find the Road to have another Bending: Placing your Inſtrument at P, in all reſpects as you did at O, with the Needle hanging directly over the Meridian-Line of the Chart, direct your Sights to Q, and note the Bearing (which you will find to be N W 35 deg.) down in your Field-book thus, 15 ⊙ N W 35 deg. with the bearing of *Newington*-Steeple, and the entring of Low *Holloway*, with Houſes on both ſides cloſe at the ſame time; then cauſe the man with the wheel to meaſure to the man at Q, which you will find to be 1 furlong and 12 poles; this 1 furlong and 12 poles note down in your Field-book againſt Q, your 16th ſtation; then placing your Inſtrument at Q, with the Needle hanging directly over the Meridian-Line of the Chart, make it there faſt, and cauſe a man to go forwards along the Road till he ſee it bend; there let him ſtand: which place will be your 17th ſtation R.

Then

Then direct your Sights to the man at R, and note the bearing (which you will find to be N W 49 deg.) down in your Field-book, thus, 16 ⊙ N W 49 deg. then cauſe the man with the Wheel to meaſure towards the man at R, and at 2 poles diſtance from Q, you will leave Low *Holloway* both to the right and left; the man with the Wheel meaſuring on till he comes to the man at R, there you will find you are 23 poles diſtance from Q; this 23 poles note down in your Field-book againſt your ſtation R.

Then placing your Inſtrument at R, turn it about till you make the Needle hang directly over the Meridian-Line of the Chart; there make it faſt: then cauſe a man to go forward along the Road till he finds another bending; there let him ſtand: which place of ſtanding ſhall be your 18th ſtation S.

Then directing your ſights to the man at S, note the bearing (which you will find to be N W 41 deg. and 30 min.) down in your Field-book thus, 17 ⊙ R N W 41 deg. 30 min. then cauſe the man with the Wheel to meaſure to the man at S, and you will find the man at S to be 35 poles diſtant from R; this 35 poles note down in your Field-book againſt your 18th ſtation S.

Then cauſe the man that ſtood at S, to go forward along the Road until he finds the Road to bend; there let him ſtand: which place of ſtanding ſhall be your 19th ſtation T.

Then placing your Inſtrument at S, turn it about till you find the Needle hang directly over the Meridian-Line; there make it faſt, and direct your Sights to the man at T, note the bearing (which you will find to be N W 61 deg.) down in your Field-Book thus, 18 ⊙ N W 61 deg.

Then

Then cauſe the man with the Wheel to go and meaſure towards the man at T, and at 1 furlong and 6 poles diſtance from S, you will enter Upper *Holloway*, and at the ſame time you will begin to aſcend the Hill.

When the man with the Wheel comes to the man at T, you will find your diſtance between S and T to be 1 furlong and 21 poles; then cauſe the man that ſtood at T, to go forward along the Road, till he finds the Road to have another bending; there let him ſtand: which place of ſtanding ſhall be your 20th ſtation V.

Then placing your Inſtrument at T, turn it about till you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt.

Then direct your Sights to the man at V, and note the bearing (which you will find to be N W 50 deg. 15 min.) down in your Field-book thus; 19 ⊙ N W 50 deg. 15 min. and againſt this, ſet down in the right hand Column 21 poles, the diſtance between S and T.

Then cauſe the man with the Wheel to meaſure towards the man at V, and at 19 poles diſtance from T, you will leave Upper *Holloway* both to the right and left; this note down in your Field-book in your left hand Column, and againſt it, in your right hand Column note down the 19 poles.

Then when you come to the man at V, you will find the diſtance between T and V to be 2 furlongs and 32 poles; this 2 furlongs and 32 poles note down in your Field-book, againſt V, your 20th ſtation.

Then cauſe the man that ſtood at V, to go forward along the Road till he finds it to have another bending; there let him ſtand: which place of ſtanding ſhall be your 21th ſtation X.

Then

Then placing your Inſtrument at V, let the Needle hang directly over the Meridian-Line of the Chart, and there make your Inſtrument faſt.

Then direct your Sights to the man at X, and note the bearing (which will be N W 44 deg.) down in your Field-Book thus; 20 ⊙ N W 44 deg. The ſame time you will ſee a Dial in the Road; note this down in your Field-book alſo.

Then cauſe the man with the Wheel to meaſure towards the man at X, and at 1 furlong and 8 poles diſtance from V, you will have a Houſe to the left, called *Spittle-Houſe*; note this down in your Field-book, as you did the former: Then when the man with the Wheel is come to the man at X, you will find the diſtance between V and X to be 1 furlong and 8 poles; this 1 furlong and 8 poles note down in your Field-book againſt X, your 21th ſtation.

Then cauſe the man that ſtood at X, to go forward along the Road, till he find it to bend; there let him ſtand: which place of ſtanding ſhall be your 22th ſtation Y.

Then placing your Inſtrument at X, with the Needle hanging directly over the Meridian-Line, make it faſt, and direct your Sights to the man at Y, noting the bearing (which you will find to be N W 53 deg.) down in your Field-book, thus; 21 ⊙ N W. 53 degrees.

Then cauſe the man with the Wheel to go and meaſure towards the man at Y, and at 25 poles diſtance from X, you will begin to enter *High-Gate*, with Houſes to the right hand; note this in your Field-book in the left hand Column, and againſt it, in the right hand Column note nown the 25 Poles.

At 37 poles you will enter *High-Gate* with Houſes

to

to the left hand alſo; note this down as you did the former; and at 1 furlong and 13 poles, you will have a Road to the right and left; the right going to *Hornſey*, the left to *Green-Street*; this Road note down in your Field-book on both ſides of the Line thus ⊣ noting down in the left hand Column to what place they go, and the diſtance in the right hand Column from the laſt ſtation.

The man with the Wheel being come to the man at Y, your 22th ſtation, you will find the diſtance between X and Y, to be 2 furlongs and 4 poles; this 2 furlongs and 4 poles note down in your Field-book againſt Y, your 22th ſtation.

Then cauſe the man that ſtood at Y, to go forward along the Road till he find another bending; where let him ſtand: which place of ſtanding ſhall be your 23th ſtation Z.

Then place your Inſtrument at Y, in the ſame manner as you did in all the other ſtations, and direct your Sights to the man at Z, and note the bearing (which you will find to be N W 70 deg. 30 min.) down in your Field-book thus; 22 ⊙ N W 70 deg. 30 min.

Then cauſe the man to meaſure with the Wheel the diſtance between Y and Z, which you will find to be 20 poles; which 20 poles note down in your Field-book againſt Z, your 23th ſtation.

Then cauſe the man that ſtood at Z, to go and ſtand at *q*; then place your Inſtrument at Z, in the ſame manner as you did at all the reſt of the ſtations; and direct your Sights to the man at *q*, noting the bearing (which you will find to be N W 63 deg.) down in your Field-book, thus; 23 ⊙ N W 63 deg.

Then cauſe the man with the Wheel to meaſure the diſtance

diſtance between Z and *q*, which will be found to be 21 pole; this 21 pole note down againſt *q*, your 24th ſtation.

Then cauſe the man that ſtood at *q*, to go and ſtand at W, your 25th ſtation; and placing your Inſtrument in all reſpects as you did before, direct your Sights to the man at W, noting the bearing (which you will find to be N W 70 deg.) down in your Field-book, thus, 24 ⊙ N W 70 deg.

Then cauſe the man with the Wheel to go and meaſure towards the man at W, and at 17 pole diſtance from *q*, you leave Houſes to the left; this note down in your Field-book, as you did before at *Holloway*.

Then when the man with the Wheel is come to the man at W, you will find the diſtance between *q* and W to be 36 pole; this 36 pole note down in your Field-book againſt W, your 25th ſtation. Then placing your Inſtrument at W, in all reſpects as you did in all the reſt of your ſtations, direct your Sight to the Gate, noting the bearing (which you will find to be N W 44 deg.) down in your Field-book, thus, 25 ⊙ N W 44 degrees.

Then cauſe the man with the Wheel to meaſure towards the Gate, and at 2 poles diſtance from W, your laſt ſtation, you will have a Road to the right and left forward; the right to *Hornſey*, the left to *Kentiſh*-Town; this note down in your Field-book on both ſides of the Line, thus ⚴; likewiſe note to what place they go on the left hand Column, and in the right hand Column the diſtance from your laſt ſtation.

At 1 furlong and 13 pole diſtance from W, you will come to the Gate.

A Table of Observations taken in measuring the Road between London *and* High-Gate, *beginning at the Pound in S.* John-Street.

	M.	*F.*	*P.*	*M.*	*F.*	*P.*
A the 1 ⊙NW 25 *d.* 0 *m.*	0	0	0	0	0	0
B the 2 ⊙NE 32 *d.* 0 *m.*	0	0	35	0	0	35
Leave Houſes to the Left.	0	0	38	0	0	0
C the 3 ⊙NW 9 *d.* 0 *m.*	0	1	17	0	0	22
D the 4 ⊙NE 7 *d.* 0 *m.* and a Houſe to the Left.	0	2	12	0	0	32
E the 5 ⊙NW 6 *d.* 30 *m.*	0	3	6	0	0	34
A Houſe to the Left.	0	3	9	0	0	0
A Bridge over the New River, and enter *Iſlington* with Houſes to the Right.	0	3	19	0	0	0
F the 6 ⊙NW 5 *d.* 0 *m.*	0	4	22	0	1	16
A Road to the right, thus, ⅄ to *Old-Street.*	0	4	27			
G the 7 ⊙NE 29 *d.* and enter *Iſlington* to the Left.	0	5	1	0	0	19
A Road thus ⊨ to *High-Gate* the Back-way.	0	5	18			
Leave Houſes to the right.	0	6	17			
A Pond and a Wooden Bridge, and a Road, thus ⅂ to *Kingſland.*	0	6	39			
H the 8 ⊙NE 96 *d.* 0 *m.*	0	7	11	0	2	10

Enter

	M.	F.	P.	M.	F.	P.
Enter Houſes to the Right.		7	23	0	0	0
I the 9 ⊙ N 9 *d.* 0 *m.*		7	27	0	0	16
K the 10 ⊙ NE 17 *d.* 30 *m.*	1	0	4	0	0	17
L the 11 ⊙ N W 0 *d.* 30 *m.*	1	0	25	0	0	21
And *Iſlington* Church to the right hand of the Road cloſe.	1	0	25			
A Road to the right to *Kingſland*, thus, ⊨ .	1	1	6			
A wooden Bridge over a Rill, and leave Houſes to the Left.	1	2	3			
Enter Houſes to the Left.	1	2	18			
A Road to the Right to *Cambury*-Houſe, and to the Left to the Back-Road that goes to *High-Gate*, thus, ⊭.	1	3	10			
A Road to the Left, thus, ⊣ to the Back-Road that goes to *High-Gate*.	1	4	2			
Leave Houſes to the Left.	1	4	6			
A Road to the Right to *Kingſland*, thus, ⊭ and M the 12 ⊙ N W 43 *d.* 0 *m.*	1	4	38	0	4	13
Jack Straw's Caſtle, a houſe to the Right, with a Conduit about a Furlong from the Road.	1	5	0			
Houſes to the Left ſcattering.	1	5	23			

	M.	F.	P.	M.	F.	P.
N the 13 ⊙ N W 34 *d.* 30′	1	6	18	0	1	20
Leave the Houſes to the Left ſcattering.	1	6	37			
A Wooden Bridge croſs the Road.	2	0	3			
A Road to the Left to *Iſlington*, thus, ⊣	2	0	4			
A Houſe to the Right and Left, and O the 14 ⊙ N W 36 *d.* 0 *m.*	2	0	32	0	2	14
A Road to the Right, thus, ⋁, to *Hornſey*.	2	1	9			
A Bridge over a Rill.	2	2	4			
A Bridge over the Road.	2	5	6			
A Road to the Left thus, ⊣	2	5	12			
Hullington a Village to the Right about a Furlong off the Road.	2	5	40			
A Houſe to the Right and Left.	2	6	17			
Newington-Church to the Right bears from your 14 ⊙ S E 88 *d.* 0 *m.*						
P the 15 ⊙ N W 35 *d.* 0 *m.*	2	7	14	0	6	22
Enter Low *Holloway*, houſes both to the Right and Left.	2	7	17			
The *Green Man* to the Left	2	7	36			
Q the 16 ⊙ N W 49 *d.* 0′. and leave Houſes both to the Right and Left.	3	0	26	0	1	12
R the 17 ⊙ N W 41 *d.* 30′.	3	1	9	0	0	23

S

	M.	F.	P.	M.	F.	P.
S the 18 ⊙ N W 61 *d.* 0 *m.*	3	2	4	0	0	35
Enter upper *Holloway* with Houſes on both ſides, and at the ſame time you will begin to aſcend the Hill.	3	3	10			
T the 19 ⊙ N W 50 *d.* 15′ and *Mother Red-Caps* Houſe to the Left.	3	3	25	0	1	21
Leave Houſes both to the Right and Left.	3	4	4			
A Sun-Dial to the Left, and at the ſame time V the 20 ⊙ N W 44 *d.* 0 *m.*	3	6	17	0	2	32
A Houſe to the Left called the *Spittle-Houſe*, X the 21 ⊙ N W 53 *d.* 0 *m.*	3	7	25	0	1	8
Enter *Highgate* with Houſes to the Right cloſe.	4	0	10			
Enter Houſes to the Left alſo.	4	0	22			
A Road to the Right to *Hornſey*, and to the Left to *Green-Street*, thus, ⊣	4	0	35			
Y the 22 ⊙ N W 70 *d.* 30′.	4	1	29	0	2	4
Z the 23 ⊙ N W 63 *d.* 0′.	4	2	9	0	0	20
W the 24 ⊙ N W 70 *d.* 0′.	4	2	22	0	0	13
Leave Houſes to the Left.	4	2	38			
The 24 ⊙ N W 41 *d.* 0 *m.*	4	3	18	0	0	36
A Road to the Right to *Hornſey*, and to *London*, by the way of *Kentiſh*-Town, thus, ⊦.	4	3	18			

	M.	F.	P.
At the Gate, and the Church to the Right, and Top of the Hill, and end of our Observations.	4	4	31

CHAP. VI.

How to protract or lay down any Observation taken according to the Directions of the last Chapter

FIrst, having provided your self of a Sheet of white Paper or Velam, draw thereon a quantity of parallel Lines, each of them about a quarter of an Inch asunder; which parallel Lines represent the East and West part of the Paper: This being done, make a Prick in the Paper in one of your Lines, to represent your first Station, which let be A in *Fig.* 44. then lay the Center of your Protractor upon this Point A, and turn the Protractor about till you make the Line A B thereof lie directly parallel to one of the parallel Lines drawn on the Paper: Then laying your Field-Book or Table of Observations before you, you will find that at your first Station the Bearing was N W 25 deg.

Then

Then againſt 25 deg. of the Protractor that lies towards the Weſt of the North, make a Mark with your protracting-pin, and draw the Line A B at length: then finding the diſtance between your firſt and ſecond ſtation to be 35 Poles, take off 35 from off your Scale of equal parts, and place it from A to B; then lay the Center of your Protractor upon the point B, and finding by your Field-Book or Table that the bearing at your ſecond Station B, was N E 32 deg. againſt 32 deg. of your Protractor, that lies towards the Eaſt-ſide thereof, make a Mark.

Then draw the Line B C at length, and finding alſo by your Field-book that the diſtance between B and C was meaſured to be 22 poles; theſe 22 poles muſt be taken off from your Scale of equal parts, and placed from B to C.

Then lay the Center of your Protractor upon the point C, and finding by your Field-book, that at C, you had a bearing N W 9 deg. againſt 9 deg. of your Protractor that lies on the Weſt-ſide thereof, make a Mark, and draw the Line C D at length.

Then becauſe the diſtance between C and D was meaſured to be 32 poles, (as by your Field-book doth plainly appear) take the 32 from off your Scale of equal parts, and place it from C to D; then lay the Center of your Protractor on the point D, and turn it about until the Line A B thereof lie directly parallel to the parallel Lines that are drawn on the Paper, (obſerve this every time you lay the Center of your Protractor on any of the points.)

Then finding by your Field-book or Table, that at the Station D, the bearing was obſerved to be N E 7 deg. therefore againſt the 7 deg. that lie on the Eaſt-ſide of your Protractor, make a Mark with your

protracting-pin, and draw the Line D E at length; and finding by your Field-book that the measured distance between D and E was 34 poles, take 34 from off your Scale of equal parts, and place it from D to E.

Then lay the Center of your Protractor on the point E, and turn it about until the Line A B thereof lie directly parallel to one of the parallel Lines that are drawn on the Paper; and finding by your Field-book or Table, that at the Station E, you observed the Road to bear N W 6 deg. and 30 min. therefore against 6 deg. and 30 min. that lie on the West-side of your Protractor, with your protracting-pin make a Mark, and draw the Line E F at length.

Then finding by your Field-book also that the measured distance between E and F 1 Furlong and 16 poles (which is 56 poles) these 56 poles take from off your Scale of equal parts, and place from E to F.

Then laying the Center of your Protractor on the point F, turn it about until the Line A B thereof lie directly parallel to one of the parallel Lines on the Paper.

Then finding by your Field-book at F, the bearing of the Road was found to be N W 5 deg. against 5 deg. that lie on the West-side of your Protractor, with your protracting-pin make a Mark, and draw the Line F G at length.

Then likewise finding by your Field-book that the measured distance between F and G was 19 poles, take 19 from off your Scale of equal parts, and place it from F to G.

Then lay the Center of your Protractor upon the point G, and turn it about till the Line A B thereof

lie

lie directly parallel to one of the Lines on the Paper.

Then finding by your Field-book, that at your station G, you obſerved the bearing to be N E 29 deg. therefore againſt 29 deg. that is on the Eaſt-ſide of your Protractor, with your protracting-pin make a Mark, and draw the G H at length.

Likewiſe you will find by your Field-book, that the meaſured diſtance between G and H was 2 Furlongs and 10 poles, that is 90 poles; therefore take 90 from off your Scale of equal parts, and place it from G to H.

Then lay the Center of your Protractor upon the point H, and turn it about until the Line A B thereof lie directly parallel to one of the Lines on the Paper.

Then finding by your Field-book that at your Station H, you found the Road to bear N E 16 deg. againſt 16 deg. that is on the Eaſt-ſide of your Protractor, with your protracting-pin make a Mark, and draw the Line H I at length.

Then likewiſe by your Field-book you will find that the meaſured diſtance between H and I was 16 poles; theſe 16 poles muſt be taken off from your Scale of equal parts, and be placed from H to I.

Then lay the Center of your Protractor on the point I, and turn it about until the Line A B thereof lie directly parallel to one of the Lines on the Paper.

Then by your Field-book you will find that at the Station I the Road did bear N E 9 deg. Then againſt 9 deg. of your Protractor that lies to the Eaſt-ſide thereof, with your protracting-pin make a Mark, and draw the Line I K at length.

Then

Then likewiſe by your Field-book you will find that the meaſured diſtance between I and K was 17 poles; therefore take 17 poles off from your Scale of equal parts, and place them from I to K.

Then lay the Center of your Protractor upon the point K, and turn it about until the Line A B thereof lie directly parallel to one of the Lines that are drawn parallel on the Paper.

Then finding by your Field-book that at the Station K, the Road was obſerved to bear N E 17 deg. 30 min. againſt 17 deg. 30 min. that is on the Eaſt ſide of the Protractor, with your protracting-pin make a Mark, and draw the Line K L at length.

You will likewiſe find by your Field-book that the meaſured diſtance between K and L was 21 poles; therefore take 21 from off your Scale of equal parts, and place it from K to L.

Then laying the Center of your Protractor upon the point L, turn it about till the Line A B thereof lie directly parallel to the Lines that are drawn on the Paper.

Then finding by your Field-book that at your ſtation L, you found the Road to bear N W. 0 deg. 30 min. therefore againſt 30 min. on the Weſt ſide of your Protractor make a Mark with your protracting-pin, and draw the Line L M at length.

In like manner muſt you proceed until you have protracted all your Stationary Lines and Angles.

☞ Note, That when you lay the Line A B of your Protractor parallel to any of the Lines that are drawn, the 0 deg. doth repreſent the North, and it is numbred 10, 20, 30 deg. on both ſides of the North towards the Eaſt and Weſt.

Having

Having in this manner protracted your ſtationary lines, you may proceed to the protraction of your other Obſervations taken, when you made your perambulation, thus.

You will find by your Field-book or Table, that at 38 poles diſtance from your firſt Station A, you left Houſes to the Left hand, therefore take 38 off from your Scale of equal parts, and place it from A your firſt ſtation, towards B, and you will find it will be 3 poles beyond B towards C, your third Station; therefore from A your firſt Station to this place, make Houſes all along on the left hand of the Road.

At D your 4th ſtation, you had a Houſe to the Left, therefore againſt D make a Houſe to the left hand of D.

At 3 poles diſtance from E your 5 ⊙, you had an Houſe to the Left, therefore take 3 from off your Scale of equal parts, and place it from E towards F, your 6th Station, and againſt it make a Houſe.

At 13 poles diſtance from E you paſſed over a Bridge made of Wood, that went over the New River, and at the ſame time you began to enter *Iſlington*, with Houſes to the right; therefore you muſt take 13 from off your Scale of equal parts, and place it from E towards F, and at that place you muſt make a Bridge and a River, and write down the Name thereof, and from whence it comes, and whither it goes, and the quality of the Bridge whether Wood or Stone.

At 5 poles from F, your 6th ſtation (you will find by your Field-book) you had a Road to the right that went to *Old-Street*, ſomething inclining backward; therefore take 5 from off your Scale of equal parts, and place it from F towards G, and at that

place

place make a Road to the right, with two Lines inclining ſomething backwards, as you found it to do by your Field-book, and write down in your Road ſo made, the Name of the place to which it leads.

At the ſame time you began to have Houſes to the left hand of you; and by your Field-book you will find that at 17 poles diſtance from G, your 7th Station, you had a Road to the Left to *High-Gate* the backway; therefore take 17 from off your Scale of equal parts, and place it from G towards H, and at that place make a Road to the left hand of the Line GH, with two Lines, and likewiſe make it to incline, as you find by your Field-book it doth; and likewiſe you muſt write down the name of the place to which it goes.

At 1 furlong 16 poles diſtance from G, you will find by your Field-book that you left Houſes to the right; therefore take 56 from off your Scale of equal parts, and place it from G towards H, and from the place you began to enter *Iſlington* with Houſes to the right; at this place make a Houſe to the right hand ſide of your Stationary Lines.

You will find likewiſe by your Field-book that at 1 furlong and 38 poles diſtance from G, you had a wooden Bridge in the Road, and a Pound, and a Road inclining forwards to *Kingſland*; therefore take 78 (for ſo many poles there are in 1 furlong 38 poles) from off your Scale of equal parts, and place it from G towards H, and in that place make a Road with two Lines to incline forwards, as you found by your Field-book the Road did; and write the name of the place whither it goes; you muſt likewiſe write down the Bridge, the quality thereof, whether Wood or Stone, and likewiſe the Pound.

You

You will find likewiſe by your Field-book that at 12 poles diſtance from H, your 8th Station, you began to enter Houſes to the right; therefore take 12 from off your Scale of equal parts, and place it from H towards I.

You will find alſo by your Field-book that at your 11th Station L, you had *Iſlington*-Church to the right hand of the Road cloſe; therefore place a Church to the right hand of the Road with a Tower-Steeple.

In this manner muſt you proceed till you have protracted the Road that you meaſured.

☞ Note, All Churches that you place on the Road, muſt be ſo placed that the Steeple may be at the Weſt-end thereof; ſo by that means when your Road lies North, and the Church on the right hand of the Road, the Steeple will be next to you; but if the Church be on the left hand of the Road, then the Steeple will be from you, and the Body of the Church will be next to you; and in that manner muſt you protract it: if your Road lies Eaſt, then you muſt protract the Church ſide by ſide with the Road; for all Steeples of Churches are on the Weſt-ſide thereof.

Note alſo, When you come to protract or lay down a Church that ſtands at a diſtance from the Road, *viz.* a Mile or more, lay down the Center of your Protractor on the place you took the bearing (thus, *At ſo many Poles diſtance from* ſuch *a Station*, ſuch *a Steeple did bear from you* ſo *and* ſo) and againſt the degrees of bearing make a Mark, and draw a Line at length.

Then at the ſecond place where you obſerved this Steeple to bear from you, lay the Center of your Protractor, and againſt the degrees of bearing make a Mark, and likewiſe draw a Line at length; and where this laſt Line of bearing doth interſect the firſt

Line

Line of bearing, there place the Steeple with the Body of the Church to the East side thereof.

All Wind-mills, eminent Houses, or other Remarks that are at distance from the Road, you must protract in the same manner as you did the Church, by the bearing thereof; and likewise write down the Name thereof; and if you protract a Village that stands at a distance from the Road, you must signifie by writing the same, that it is a Village.

When you come to protract a Village that is in the Road with Houses scattering, you must place your Houses scattering on the right or left hand the Road, as you found them to scatter when you took it.

When you protract a Market-Town, you must write down the Name thereof in another kind of Letter, and by that means you will come to know which are Market-Towns, and which not.

You must protract the Road all along with two Lines parallel one to the other; if your Road have Hedges on both sides; then draw your Lines black; but if your Road be open way, then draw it with prick'd Lines; you must also write down the quality of the Ground, whether it be a Common, Moor or Arable Ground.

If your Road pass through a Wood, then make little Trees on both sides the Road, to signifie the same.

If the Road go a Mile in the Wood, place Trees a Mile on the Road, to represent the same.

When your Road passes over a Hill, you must at the beginning where the Hill doth ascend, shadow very deep, and as the Hill doth more and more ascend, you must shadow it lighter and lighter, till you come to the top thereof; if it be a Mile, you must do so,

if

If there be a Town or Village upon the ſide of the Hill, you muſt ſhadow it likewiſe ſo that the Houſe may be ſeen; if the Remarks that are at a diſtance from the Road ſtand on a Hill, make a Hill to repreſent the ſame.

If your Road paſs by or through a Park, Foreſt, or Chaſe, write down on your Road protracted, where you did enter the ſame, and where you did leave it, writing the Name thereof among the Trees.

If your Road paſs over a Ford, draw the River quite croſs the Road, to ſignifie there is no Bridge, and write the Name of the Ford; but if there be a Bridge, then draw the River on both ſides the Road, till it touch the parallel Lines, and write the Name both of the Bridge and the River: Likewiſe write on that ſide of the Road that the Stream runs from you, to what place the River doth empty it ſelf, and on the other ſide of the Road write from whence the Water or River hath its Riſe, if you can poſſibly learn that of the Inhabitants.

All Rills you may ſignifie by drawing a Line croſs the Road; and Brooks may be ſignified by drawing two Lines croſs the Road; and Rivers by more Lines, together with the Names; for all Rivers have Names, but Rills and Brooks have none.

If it chance that the Road ſhould lie over a River that is a Furlong or a Mile or more, to find the breadth thereof, it will be convenient to obſerve theſe Rules following.

When you come to the River ſide that you are to be ferried over, you muſt take a bearing to ſome noted thing on the other ſide where you are to Land, as a Steeple or other thing, and note it down in your Field-Book.

Then

Then take a bearing to some Mark on the same side of the River that you stand to take the bearing; then measure with your Wheel in as straight a Line as you can to the Mark which you took the bearing to, and when you are come to the Mark at that place, take a bearing to the same Mark that you did before at the Ferry on the other side of the River, and note the bearing down in your Field-book, and likewise the distance measured between both your Observations: Then when you come to protract your Observations, observe this Rule.

Lay the Center of your Protractor on the place of standing on the Road at the Ferry, and turn it about until the Line A B thereof lie directly parallel to one of the parallel Lines drawn on the Paper; then against the degrees of bearing of your Protractor make a Mark; likewise against the degrees of bearing of your second station, make a Mark, and draw these two Lines at length.

Then set off the distance measured between your two stations, upon the second Line drawn, and at the end thereof lay the Center of your Protractor, turning about till the Line A B thereof lie directly parallel to one of the Lines drawn on the Paper.

Then against the degrees of bearing of the place on the other side of the River make a Mark, and draw a Line through that Mark, and where that Line doth intersect the first Line drawn at your first station, that point doth shew the breadth of the River. This River you must draw to its true breadth, and make a prick'd Line cross the River, to represent the passage of the Ferry-Boat; and note down the side of the River on which you take Boat, and the Name of the Ferry.

If your Road lie along by a River ſide, then draw a River along by the ſide of the Road that you have protracted, with the name of the ſame; or if your Road ſhould chance to have a Brook or Rill run along it, as *Enfield*-Waſh doth, write it down on the Road ſo protracted, to ſignifie the ſame.

Likewiſe you muſt take notice when you enter a County, upon the Road ſo protracted draw a Line croſs the Road, with a prick'd Line by it, and by or upon this Line write the Name of the County you enter.

It will likewiſe be neceſſary that you take notice of the quality of the Way, whether it be Stony or Clayie, or Boggy, and write it down on the Road that you have protracted, and by this means you will come to have your Road mighty full of Remarks, and it will ſhew very delightful.

In this manner have I protracted the Road from *London* to *High-Gate* to a Scale of 40 pole to an Inch, and have reduced it to a Scale of an Inch in a Mile, as in *Fig.* 45 doth appear, and *Fig.* 44 is from *London* to *Iſlington*-Church to a Scale of 40 poles to an Inch, for Inſtruction how to protract the Road. They that do but obſerve thoſe Rules which I have ſet down both for taking the Obſervations, and protracting of them when taken, may very eaſily make a Map of any Road whatſoever.

CHAP. VII.

How to take the Plot of a River or Brook by the Wheel and Semicircle.

FOraſmuch as the Rivers in our County-Maps, nay of all Counties whatſoever, are moſt, if not all of them, falſe; and that the whole dependency of drawing a County-Map, as it ought to be done, relies wholly upon taking the Rivers and Roads true, and that the young Surveyor may not be to ſeek when ſuch a thing is required of him, I have taken upon me to give him ſuch Rules as may be ſufficient; but if any one object againſt them, and ſay he could have given better, let ſuch as thoſe conſider I had no other ſhoulders to build upon but my own; nor could I ever lay my hands on any Author that did ſo much as touch upon the taking the Plot of a River: what the reaſon ſhould be that they have not done it, I know not. It may chance I may give offence to thoſe that have formerly treated of Surveying, and have not done the ſame that I do; yet I know no reaſon for it: but if ſome are diſpleaſed, I am confident I ſhall pleaſe many young Surveyors that are willing to be inſtructed; and for their ſakes chiefly it is that I have been ſo plain; therefore if they be minded at any time to make a Map of any River, let them obſerve theſe following Rules.

When you come to the Mouth of the River that you

you are minded to take a Map of, cauſe a man to go and ſtand at the next Bend of the River; then plant your Inſtrument at the Mouth of the River, letting the Needle hang directly over the Meridian-Line of the Chart; there make it faſt; and direct your Sights to the man that ſtands at the next Bending of the River, and note down the bearing in your Field-book, as you did in the Road.

Then cauſe the man that drives the Wheel to meaſure between your firſt ſtation and the man at the next Bending, and note that down alſo in your Field-book under *Miles*, *Furlongs* and *Poles*.

Then bring your Inſtrument to the man at the firſt bending of the River, and cauſe that man to go forward till he finds another bending; there let him ſtand: and placing your Inſtrument where the man laſt ſtood, let (as before) your Needle hang directly over the Meridian-Line of the Chart, and there make your Inſtrument faſt, and direct your Sights to the man that ſtands at the next bending of the River, and note the bearing down in your Field-book as you did in the former; and thus muſt you proceed all along the River to the Head thereof.

Note, in meaſuring the River thus, you are to obſerve what Bridges you paſs by, and note them down in your Field-book, with the Quality thereof, whether they be Wood or Stone; and againſt it note the Furlongs and Poles that the Bridge is from your laſt ſtation, under the *Miles*, *Furlongs* and *Poles*.

Likewiſe you muſt take notice of all the *Water-Mills* that ſtand upon the River, and the Quality of them, whether they be *Corn-Mills*, *Paper-Mills*, or *Powder-Mills*. Upon ſome Rivers you will have *Rape-Mills*; note down in the right hand Column of your

Field-book the diſtance this Mill or Mills is both from the Mouth of the River and your laſt ſtation.

You muſt likewiſe take notice of all the Sluces (if they be never ſo many) that are on the River, with their diſtance both from the Mouth of the River and your laſt ſtation.

You muſt alſo take an account of all the Locks or Flood-Gates that are upon the River as you meaſure along; noting down in your Field-book their diſtance both from the Mouth of the River and your laſt ſtation.

If either the Bridges, Mills, Sluces or Locks have any Names, note them down in your Field-book alſo.

You muſt alſo take an account of all the Ferries that are upon the River, and note them down in your Field-book, with their Names, and their Diſtance both from the Mouth of the River, and from your laſt ſtation.

You muſt alſo take an Account of thoſe places of the River that are Fordable, and note them down in your Field-book, with their diſtance from your laſt ſtation, and alſo their diſtance from the Mouth of the River.

Obſerve alſo where any other Brook or River enters into that you are meaſuring, and note down the place, and the Name of the River that comes in; and note the diſtance from your laſt ſtation, and from the Mouth of the River you are meaſuring.

You muſt likewiſe note down in your Field-book all the Towns this River doth run through or by, with the Towns Name, and diſtance from your laſt ſtation and the Mouth of the River.

You muſt likewiſe take notice if there be any cut

Rivers

Rivers from the River that you are meaſuring, noting down where it goes out of the River, and where it comes in again, with the diſtance as before; and likewiſe for what end it was ſo cut.

You muſt alſo take an account of all the Churches that are on each ſide the River, by taking a bearing to them at two ſeveral places, and note them down in your Field-book, with the diſtance of the place from your laſt ſtation where you took the bearing to the Steeple both times; by this means you will come to know how far each Church is diſtant from the River.

The ſame you muſt do by all the Wind-Mills that are in ſight of you when you meaſure the River; and alſo all Great Houſes, noting the Names of the ſeveral places down in your Field-book, and in what County they ſtand; for it is uſual with a River to part Counties, as *Thames* parts *Middleſex* and *Surrey*, *Eſſex* and *Kent*.

All Beacons that ſtand in ſight of the River you muſt take with the like exactneſs as you did the Churches.

When you have thus meaſured your main River, begin to meaſure the ſeveral Branches thereof; for there are but few Rivers but have many ſmaller Rivers running into them, and all thoſe ſmall Rivers ought to be done with the like exactneſs with the great ones.

Note, All Rivers that are Navigable, every bending of them muſt be taken exactly; but for other ſmall Creeks there is no great need; for you will find ſuch ſmall Brooks to have a Bend at every two or three poles; nay, ſometimes leſs: therefore they are to be taken thus; Take your Sights as far as you can con-

veniently, till you find the Brook to have a conſiderable bending, and if your Scale will permit, you may take your Off-ſets to repreſent the ſmall turnings and windings thereof; but in meaſuring a ſmall Brook, if your Scale is to be a Mile or two in an Inch, then thoſe ſmall turnings and windings cannot be deſcribed in the Map.

CHAP. VIII.

Containing an Explanation of the Rules in the foregoing Chapter, by way of Example, in a Part of a River, by me actually meaſured for that end, beginning at Jeremiah's *Ferry upon* Hackney-River, *and ſo a Mile beyond the* Paper-Mills.

FIrſt having prepared a Field-book that is ruled with two Columns towards the right hand of each Page, one to note down the diſtance from your firſt ſtation, the other to note down the diſtance from every ſtation, the great Column towards the left hand will be to note down your Obſervations.

Then place your Inſtrument againſt the Ferry on *Middleſex* ſide, and cauſe a man to go forward by the River ſide till he find the River bend; there letting him ſtand, turn your Inſtrument about until the Needle hang

hang directly over the Merid. Line of the Chart; there make it fast, and direct your Sights to the man that ſtands at the next bending of the River; firſt noting down the Name of the place where you begin, and the Houſe that ſtands on the other ſide of the River, called *Jeremiah's Booth*, note down the bearing, which you will find to be N W 74 deg. 0 min. in your Field-Book thus; A your 1 ⊙ N W 74 deg. 0 min. and againſt it in the right hand Column note nothing but 00 00.

Then cauſe the man with the Wheel to meaſure forward to the man at B, your ſecond Station and you will find the diſtance from your firſt Station to the man at the ſecond, will be 18 Poles; which 18 poles ſet down in your Field-Book againſt B, your ſecond ſtation.

Then cauſe the man that ſtood at B to go forward along the River ſide until he find another bending, and there let him ſtand; which place of ſtanding will be your third ſtation C.

Then placing your Inſtrument at B, turn it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt; and direct your Sights to the man at C, and note down the bearing (which you will find to be N W 40 deg.) in your Field-Book thus, B 2 ⊙ N W 40 deg.

At the ſame time you will find *Waltham-Stow*-Church to bear from you N E 42 deg. note this down in your Field-book alſo.

Then cauſe the man with the Wheel, to meaſure towards the man at C, and at 1 Furlong 6 Poles you will have a Houſe on the ſame ſide of the River that you are meaſuring; note down the Houſe in your left hand Column, and againſt it in your right hand

Column note down the 1 Furlong and 6 Poles.

You will likewiſe find the diſtance between your ſecond ſtation and your third ſtation C, to be 1 Fur. long 8 Poles; theſe Poles and Furlongs note down in your Field-book againſt C, your third Station.

Then cauſe the man that ſtood at C, to go forward on the River ſide till he find another bending; there let him ſtand: which place of ſtanding let be your fourth ſtation D.

Then place your Inſtrument at C, your third ſtation, and let the Needle hang directly over the Meridian-Line of the Chart, and there make your Inſtrument faſt, and direct your Sights to the man at D, and note the degrees of bearing (which you will find to be N E 57 deg.) down in your Field-book thus, C the 3 ⊙ N E 57 deg.

Then cauſe the man with the Wheel to meaſure towards the man at D, and you will find the man at D to be diſtant from your third ſtation C, 24 Poles; theſe 24 poles note down in your Field-book againſt D, your fourth ſtation.

Then being at D, cauſe the man that ſtood there, to go forward along the River ſide, till he find the River to have another bending; where let him ſtand, and that place where he ſtandeth ſhall be your fifth ſtation E.

Then placing your Inſtrument at D, turn it about till the Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at E, and note the bearing (which you will find to be N W 34 deg.) down in your Field-book, thus, D the 4 ⊙ N W 34 deg.

Then cauſe the man with the Wheel to go and meaſure toward the man at E, and at 1 Furlong 26 poles diſtance

diſtance from D, you will have a Ditch and a Hedge to left hand of the River; this Ditch and Hedge note down in the left hand Column of your Field-book, and againſt it in the right hand Column thereof note down 1 furlong 26 poles.

Then meaſuring ſtill towards the man at E, at 3 furlongs diſtance from D, you will have another Hedge and Ditch to the left hand ſide of the River; note this down in your Field-book, as you did the other Hedge and Ditch, with the 3 Furlongs againſt it in the right hand Column.

The man with the Wheel being come to the man at E, the diſtance between D and E will be found to be 3 furlongs 30 poles; theſe 3 furlongs and 30 poles note down in your Field-book againſt E, your fifth ſtation; and there you will have a Hedge and a Ditch to the left hand of the River; note this down alſo at the ſame time and place you note down the fifth ſtation.

Then cauſe the man that ſtood at E, to go forward along the River ſide till he find the River to have another bending; there let him ſtand; which place of ſtanding ſhall be your ſixth ſtation F.

Then placing your Inſtrument at E, let the Needle hang directly over the Meridian-Line of the Chart, and there make it faſt, and direct your Sights to the man at F, and note the degrees of bearing (which you will find to be N W 51 deg.) down in your Field-book, thus, E the 5th ⊙ N W 51 deg.

Then cauſe the man with the Wheel to meaſure toward the man at F, and when he comes there, you will find the diſtance between the Station E and F, to be 1 Furlong 9 Poles; note theſe down in your Field-book againſt F, your 6th Station.

Then

Then at the Station F, you will find alſo a Road to the left hand of the River, that goes to *Newington*, and a few Houſes alſo, call'd *Panes*; this Road and Houſes note down at the ſame time and place that you noted the Bearing.

Then cauſe the man that ſtood at F, to go forward along the River ſide till he find it to have another bending; there let him ſtand: which place of ſtanding ſhall be your 7th Station G,

Then placing your Inſtrument at F, with the Needle hanging directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man at G, and note the degrees of bearing (which you will find to be N W 2 deg.) down in your Field-book, thus, F the 6th ⊙ N W 2 deg.

Then cauſe the man with the Wheel to meaſure from your Station F, to the man at G, and the diſtance will be found to be 17 Poles; theſe 17 Poles muſt be noted down in your Field-book againſt G, your 7th Station.

Then cauſe the man that ſtood at G, to go forward along the River ſide until he find the River to have another bending, and there let him ſtand.

Then placing your Inſtrument at G, turn it about until the Needle doth hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man that ſtands at H, noting the degrees of bearing (which you will find to be N W 33 deg. 30 min.) down in your Field-book, thus, G the 7th ⊙ N W 33 deg. 30 min.

Then cauſe the man with the Wheel to meaſure to the man at H, your 8th Station, and the diſtance between G and H will be found to be 27 Poles; theſe 27 Poles note down in your Field-book againſt H, your 8th Station.

Then

Then cauſe the man that ſtood at H to go forward along the River ſide until he finds it to have another bending, and there let him ſtand; which place of ſtanding ſhall be your 9th Station I.

Then placing your Inſtrument at H, with the Needle hanging directly over the Meridian-Line, there make it faſt, and direct your Sights to the man at I, and note the degrees of bearing (which you will find to be N W 81 deg.) in your Field-book, thus, H the 8th ⊙ N W 81 deg.

Then cauſe the man with the Wheel to go and meaſure the diſtance between H your 8th Station, and the man at I, and you will find the diſtance to be 19 Poles; theſe 19 Poles note down in your Field-book againſt I, your 9th Station.

Then cauſe the man that ſtood at I to go forward along the River ſide, till he find it to have another bending, and there let him ſtand; which place of ſtanding ſhall be your 10th Station K.

Then placing your Inſtrument at I, turn it about until your Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at K, noting the degrees of bearing (which you will find to be NE 2 deg.) down in your Field-book, thus, I the 9th ⊙ N E 2 deg.

At the ſame time you will find that at your 9th ſtation you had a Hedge to the left hand of the River; this note down in your Field-book alſo.

Then cauſe the man with the Wheel to go and meaſure towards the man at K, and at 16 poles diſtance from I, your 9th Station, you will have a little Iſland lying in the River; note this down in the left hand Column of your Field-book, and againſt it in the right

right hand Column, note down the 16 poles.

At the ſame time you will find a Ditch and a Hedge to the left hand ſide of the River; note this down in your Field-book alſo.

The man with the Wheel ſtill meaſuring on until he comes to the man at K, the diſtance will be found to be 1 furlong 4 poles. This 1 furlong 4 poles note down in your Field-book againſt K your 10th Station.

At this Station K, you will have the Mouth of a cut River that comes from the *Powder-Mills* on *Eſſex* ſide of the River; this note down in your Field-book alſo.

At the ſame place plant your Inſtrument, and cauſe the man that ſtood at the place where your Inſtrument is now, to go and ſtand at the next bending of the River, which place of ſtanding ſhall be your 11th ſtation L.

Then turn your Inſtrument about until you find the Needle hang directly over the Meridian Line of the Chart, there make it faſt, and direct your Sights to the man at L, and note the degrees of bearing (which you will find to be S W 58 deg.) down in your Field-book, thus, K the 10th ⊙ S W 58 deg.

Then cauſe the man with the Wheel to go and meaſure to the man at L, and the diſtance between K and L will be found to be 27 Poles; theſe 27 Poles note down in your Field-book againſt L, your 11th Station.

Then cauſe the man that ſtood at L to go forward along the River ſide until he comes to another bending of the River, where let him ſtand; and that place of ſtanding ſhall be your 12th ſtation M.

Then placing your Inſtrument at L, turn it about until

until the Needle doth hang directly over the Meridian Line of the Chart; there make it faſt, and direct your Sights to the man at M, and note the degrees of bearing (which you will find to be NE 4 deg.) down in your Field-book, thus, L the 11th ⊙ N E 4 deg.

Then cauſe the man with the Wheel to go and meaſure towards the man at M, and at 6 Poles diſtance from L, you will have a Bridge over a Ditch, and a Hedge to the left hand of the River; this Hedge, Ditch and Bridge note down in the left hand Column of your Field-book, and againſt it in the right hand Column, note down the 6 Poles.

Then cauſing the man with the Wheel to meaſure ſtill on, at 35 Poles diſtance from L, your 11th ſtation, you will have another Ditch and Hedge to the left hand ſide of the River; this note down in your Field-book as you did the other, and againſt it note down the 35 Poles.

Then being come to the man at M, the diſtance between L and M will be found to be 1 Furlong 24 Poles; theſe 1 Furlong 24 Poles note down in your Field-book againſt M your 12th ſtation.

Then cauſe the man that ſtood at M, to go forward along the River ſide until he find it to have another bending; and there let him ſtand: which place of ſtanding ſhall be your 13th ſtation N.

Then placing your Inſtrument at M, turn it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at N, and note the degrees of bearing (which you will find to be N W 9 deg.) down in your Field-book, thus, M the 12th ⊙ N W. 9 deg.

At

At this ſtation M, you will have a cut River to the Left, and a Houſe and Road to *Stamford-Hill*; theſe note down in your Field-book when you note down your ſtation.

Then cauſe the man with the Wheel to go and meaſure towards the man at N, and at 15 Poles diſtance from M you will have a Bridge, and an Hedge, and an Iſland alſo on the left hand ſide of the River; theſe note down in the left hand Column, and againſt it in the right hand Column of your Field-book note down the 15 Poles.

At 1 Furlong 5 Poles you will have another Iſland lying on the left ſide of the River, note this down in your Field-book as you did the others.

At 1 Furlong 30 Poles diſtance from M, you will have a Hedge and a Ditch on the Left hand ſide of the River; this Hedge and Ditch note down in the left hand Column of your Field-book, and in the right hand Column thereof note down the 1 Furlong 30 Poles.

When the man with the Wheel is come to the man at N, you will find the diſtance between M and N to be 2 Furlongs 27 Poles; theſe 2 Furlongs 27 Poles note down in your Field-book againſt N, your 13th ſtation.

Then cauſe the man that ſtood at N, to go along the River ſide until he find another bending; there let him ſtand: which place of ſtanding ſhall be your 14th ſtation O.

Then placing your Inſtrument at N, turn it about until the Needle thereof hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at O, and note the degrees of bearing (which you will find to be NE 33 deg.)

deg.) down in your Field-book, thus, N the 13 ⊙ NE 33 deg.

Then cauſe the man with the Wheel to go and meaſure towards the man at O, and at 17 Poles diſtance from N you will have a Hedge and a Ditch on the the left hand ſide of the River; this Hedge and Ditch note down in the left hand Column of your Field-book, and againſt it in the right hand Column thereof note down the 17 Poles.

Meaſuring on ſtill towards O, at 27 Poles diſtance from N, you will have another Hedge and Ditch, which you muſt note down in your Field-book as you did the former.

At 1 Furlong and 12 Poles diſtance from N, you will have another Hedge and Ditch, and an Iſland lying on the left ſide of the River; theſe note down in your Field-book as before.

At 2 Furlongs and 14 Poles you will have another Iſland lying on the left ſide of the River; this Iſland note down in the left hand Column of your Field-book, and againſt it in the right hand Column thereof note down the 2 Furlongs and 14 Poles.

At 2 Furlongs and 23 Poles diſtance from N, you will come to the man at O.

Then cauſe the man that ſtood at O to go forward along the River ſide until he find the River to have another bending; there let him ſtand; which place of ſtanding ſhall be your 15 ſtation P.

Then place your Inſtrument at O, and letting the Needle hang directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man at P; noting the degrees of bearing (which you will find to be NE 35 deg.) down in your Field-book,

book, thus, O the 14th ⊙ N E 35 degrees.

Then cauſe the man with the Wheel to go and meaſure towards the man at P, and at 15 Poles diſtance from O, you will have the Mouth of a cut River that belongs to the *Paper-Mills*; the Mouth of this River note down in your Field-book in the left hand Column thereof, and againſt it, in the right hand Column thereof you muſt note down the 15 Poles.

Then croſſing this cut River, cauſe the man with the Wheel to meaſure forward to P, and the diſtance between O and P will be found to be 22 Poles; theſe 22 Poles muſt be noted down in your Field-book againſt P your 15th ſtation.

Then cauſe the man that ſtood at P to go forward along the River ſide until he find it to have another bending; there let him ſtand: which place of ſtanding ſhall be your 16th ſtation *q*.

Then placing your Inſtrument at *q*, turn it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt; and direct your Sights to the man at *q*, and note the degrees of bearing (which you will find to be N E 14 deg.) down in your Field-book, thus, P the 15th ⊙ N E 14 deg.

Then cauſe the man with the Wheel to meaſure to the man at *q*, and the diſtance between P and *q* will be found to be 20 Poles; theſe 20 Poles note down in your Field-book againſt *q* your 16th ſtation.

Then cauſe the man that ſtood at *q* to go along the River ſide, and where he finds the River to have another bending there let him ſtand; and that place of ſtanding ſhall be your 17th ſtation R.

Then place your Inſtrument at *q*, and turn it about until you find the Needle hang directly over the Meridian

Meridian-Line of the Chart, there make your Instrument fast, and direct your Sights to the man at R, and note the bearing (which you will find to be NE 43 deg.) down in your Field-book, thus, 9 the 16 ⊙ 43 deg.

Then cause the man with the Wheel to go and measure towards the man at R, and at 1 Furlong 10 Poles you will have a House on the right hand side of the River called *Abraham's* Ferry, and to the left the *Paper-Mills*. This Ferry and Mills note down in the left hand Column, and against it in the right hand Column of your Field-book note down the 1 Furlong 10 Poles.

Then being come to the man at R, the measured distance between 9 and R will be found to be 1 Furlong 10 Poles; these 1 Furlongs 10 Poles note down in your Field-book against R, your 17th station.

Then cause the man that stood at R, to go along the River side until he find another bending; there let him stand: which place of standing shall be your 18th station S.

Then placing your Instrument at R, turn it about until the Needle thereof hang directly over the Meridian-Line of the Chart; there make it fast, and direct your Sights to the man at S, and note the degrees of bearing (which you will find to be NE 27 deg.) down in your Field-book, thus, R the 17 ⊙ NE 27 deg.

Then cause the man with the Wheel to go and measure towards the man at S, and the distance between R and S will be found to be 20 Poles; these 20 Poles note down in your Field-book against S your 18th station.

Then cause the man that stood at S to go forward

along the River ſide until he find the River to have another bending; there let him ſtand; which place of ſtanding ſhall be your 19 ſtation T.

Then place your Inſtrument at S, and letting the Needle hang directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man at T; noting the degrees of bearing (which you will find to be N W 17 deg.) down in your Field-book, thus, S the 18th ⊙ N W 12 degrees.

Then cauſe the man with the Wheel to go and meaſure towards the man at T, and you will find the meaſured diſtance to be 16 Poles; theſe 16 Pole note down in your Field-book againſt T your 19th ſtation.

Then cauſe the man that ſtood at T to go forward along the River ſide until he find it to have another bending; there let him ſtand: which place of ſtanding ſhall be your 20th ſtation V.

Then placing your Inſtrument at T, turn it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt; and direct your Sights to the man at V, and note the degrees of bearing (which you will find to be N E 20 deg.) down in your Field-book, thus, T the 19th ⊙ N E 20 deg.

Then cauſe the man with the Wheel to meaſure towards the man at V, and at 14 Poles diſtance from T, you will have a Ditch that comes out of the cut River that runs to the *Paper-Mills*, and ſo into the River you are meaſuring; this note down in the left hand Column of your Field-book, and againſt it in the right hand Column thereof note down the 14 Poles.

At 27 Poles diſtance from T, you will have another Ditch in the ſame manner as you had in the laſt;

laſt; this note down in your Field-book alſo.

When the man with the Wheel is come to the man at V, you will find the meaſured diſtance to be 1 Furlong and 1 Pole; which 1 Furlong and 1 Pole note down in your Field-book againſt V your 20th ſtation.

Then cauſe the man that ſtood at V, to go forwards along the River ſide until he find it to have another bending; and there let him ſtand: which place of ſtanding ſhall be your 21th ſtation W.

Then placing your Inſtrument at V, turn it about until you find the Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at W, and note the degrees of bearing (which you will find to be N E 37 deg.) down in your Field-book, thus, V the 20th ⊙ N E. 37 deg.

Then cauſe the man with the Wheel to meaſure the diſtance between V and W, and you will find it to be 32 Poles; this 32 Poles note down in your Field-book againſt W, your 21th ſtation.

Then cauſe the man that ſtood at W, to go forward along the River ſide till he find the River to have another bending; there let him ſtand; which place of ſtanding ſhall be your 22 ſtation X.

Then placing your Inſtrument at W, let the Needle hang directly over the Meridian-Line of the Chart, and there make it faſt, and direct your Sights to the man at X, and note the degrees of bearing (which you will find to be N E 79 deg.) down in your Field-book, thus, W the 21 ⊙ N E 79 deg.

Then cauſe the man with the Wheel to meaſure toward the man at X, and the diſtance between W and X will be found to be 38 Poles; note theſe 38 Poles

down in your Field-book againſt X, your 22 Station.

Then cauſe the man that ſtood at X to go forward along the River ſide until he comes to another bending of the River, where let him ſtand; and that place of ſtanding ſhall be your 23 ſtation Y.

Then placing your Inſtrument at X, turn it about until the Needle doth hang directly over the Meridian Line of the Chart; there make it faſt, and direct your Sights to the man at Y, and note the degrees of bearing (which you will find to be NE 37 deg.) down in your Field-book, thus, X the 22 ⊙ N E 37 deg.

Then cauſe the man with the Wheel to meaſure the diſtance between your Station X, and the man at Y, and their diſtance will be found to be 1 Furlong 8 Poles; theſe 1 Furlong 8 Poles note down in your Field-book againſt, your 23 Station.

Then cauſe the man that ſtood at Y, to go forward on by the River ſide till he find another bending; there let him ſtand: which place of ſtanding let be your 24 ſtation Z.

Then place your Inſtrument at Y, and let the Needle hang directly over the Meridian-Line of the Chart, and there make your Inſtrument faſt, and direct your Sights to the man at Z, and note the degrees of bearing (which you will find to be N W 20 deg.) down in your Field-book thus, Y the 23 ⊙ N W 20 deg.

Then by the Wheel you will find the meaſured diſtance between X and Z, to be 33 Poles; theſe 33 poles note down in your Field-book againſt Z, your 24 ſtation.

Then cauſe the man to go and ſtand at Q, the next bending of the River; then place your Inſtrument at

at Z, and direct your Sights to the man at Q, and note the bearing (which you will find to be N E 20 deg.) down in your Field-book, thus, Z the 24 ⊙ N E 20 deg.

Then cauſe the man with the Wheel (as you did before) to meaſure the diſtance between Z and Q, and their diſtance will be found to be 19 poles; theſe 19 poles note down in your Field-book againſt Q, your 25 ſtation.

Then cauſe the man that ſtood at Q to go forward along the River ſide, till he find it to have another bearing, and there let him ſtand; which place of ſtanding ſhall be your 26 Station 4.

Then placing your Inſtrument at Q, turn it about until your Needle hang directly over the Meridian-Line of the Chart; there make it faſt, and direct your Sights to the man at 4, noting the degrees of bearing (which you will find to be S E 40 deg.) down in your Field-book, thus, Q the 25 ⊙ S E 40 deg.

Then cauſe the man with the Wheel to go and meaſure towards the man at 4, and at 1 pole diſtance from Q, you will have the Mouth of the cut River that goes to the *Powder-Mills* on the right hand ſide of the River; note this down in the left hand Column of your Field-book, and againſt it in the right hand Column, note down the 1 poles.

The man with the Wheel ſtill meaſuring on until he comes to the man at 4, the meaſured diſtance between Q and L will be found to be 24 poles. This 24 poles note down in your Field-book againſt 4 your 26th Station.

Then cauſe the man that ſtood at 4 to go forward along the River ſide until he finds it to have another

bending, and there let him ſtand; which place of ſtanding ſhall be your 27th Station ♄.

Then placing your Inſtrument at ♃, with the Needle hanging directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man at ♄, and note the degrees of bearing (which you will find to be N E 14 deg.) in your Field-book, thus, ♃ the 26th ☉ N E 14 deg.

Then cauſe the man with the Wheel to go and meaſure to the man at ♄, and you will find the diſtance between ♃ and ♄, will be 23 Poles; theſe 23 Poles note down in your Field-book againſt ♄, your 27th Station.

Then cauſe the man that ſtood at ♄, to go forward along the River ſide till he find it to have another bending; there let him ſtand: which is the place where the cut River comes out of the River you are meaſuring.

Then placing your Inſtrument at ♄, with the Needle hanging directly over the Meridian-Line of the Chart, there make it faſt, and direct your Sights to the man that ſtands at the Mouth of the River that goes to the *Paper-Mills*, and the bearing will be found to be N W 49 deg. and the meaſured diſtance 31 Poles.

Here follows a Table of all the Obſervations taken according to the foregoing Directions.

A

A Table of Observations taken in measuring part of Hackney-*River; standing in the Form as it ought to do in your Field-Book.*

	M.	F.	P.	M.	F.	P.
Jeremiah's House, called *Jeremiah's* Booth, on the right hand side of the River, that being *Essex* side, and our first Station being on *Middlesex* side.						
A the 1 ⊙ NW 74 *d.* 0 *m.*	0	0	0	0	0	0
B the 2 ⊙ N W 40 *d.* 0 *m.*	0	0	18	0	0	18
And *Waltham-Stow* Church it being a Tower-Steeple, bare at the same time N E 42 *d.* 0 m.						
A House to the Left close to the River side.						
C the 3 ⊙ N E 57 *d.* 0 *m.*	0	1	26	0	1	8
D the 4 ⊙ N W 34 *d.* 0 *m.*	0	2	10	0	0	24
A Hedge and Ditch to the Left side of the River.						
A Hedge and Ditch to the Left side of the River.						
A Hedge and Ditch to the Left side of the Ri-						

	M.	F.	P.	M.	F.	P.
ver, and E the 5 ⊙ NW 51 *d.* 0 *m.*	0	6	0	0	3	30
A Road to the Left, and 2 or 3 Houſes called *Panes*, and F the 6 ⊙ NW 2 *d.* 0 *m.*	0	7	9	0	1	9
G the 7 ⊙ NW 33 *d.* 30'.	0	7	26	0	0	17
H the 8 ⊙ NW 81 *d.* 0 *m.*	1	0	13	0	0	27
I the 9 ⊙ NE 2 *d.* 0 *m.*	1	0	32	0	0	19
An Iſland lying on the left ſide of the River, with a Ditch and Hedge alſo.	1	1	18			
The cut River that comes from the *Powder*-Mills on *Eſſex* ſide, comes into *Hackney*-River, and K the 10 ⊙ SW 58 *d.* 0 *m.*	1	2	12	0	1	20
L the 11 ⊙ NE 4 *d.* 0 *m.*	1	2	39	0	0	27
A Bridge and Hedge on the Left ſide of the River.	1	3	5			
A Hedge and Ditch to the Left of the River.	1	3	36			
A Road to the Left to *Stamford*-Hill, and a cut River, and one Houſe at the end of it, with a Bridge over it of Wood; and M the 12 ⊙ NW 9 *d.* 0 *m.*	1	4	23	0	1	24
A Ditch and an Iſland ly-						

	M.	F.	P.	M.	F.	P.
ing on the left hand side of the River.	1	4	38			
An Island lying on the left hand side of the River, at the middle whereof is an Hedge and a Ditch on the Left.	1	5	28			
	1	6	13			
N the 13 ⊙ NW 33 *d.* 0′	1	7	10	0	2	27
A Hedge and a Ditch to the Left.	1	7	27			
A Ditch to the Right over the River.	1	7	37			
A Hedge and a Ditch with an Island lying on the left hand side of the River.	2	0	22			
An Island lying on the left hand of the River.	2	1	24			
O the 14 ⊙ NE 35 *d.* 0 *m.*	2	1	33	0	1	3
The cut River comes into the main River from the *Paper-Mills.*	2	2	8			
P the 15 ⊙ NE 14 *d.* 0 *m.*	2	2	15	0	0	22
Q the 16 ⊙ NE 43 *d.* 0′.	2	2	35	0	0	20
Abrahams Ferry, a House to the right over the River, and the *Paper-Mills* to the left hand about a Furlong.	2	4	5			
R the 17 ⊙ NE 27 *d.* 0′.	2	4	5	0	1	10
S the 18 ⊙ NW 12 *d.* 0 *m.*	2	4	25	0	0	20
T the 19 ⊙ NE 20 *d.* 0′.	2	5	1	0	0	16

	M.	F.	P.	M.	F.	P.
A Ditch that comes out of the cut River that belongs to the *Paper-Mills*, and runs into the main River.	2	5	15			
Another that comes from the ſame place.	2	5	25			
V the 20 ⊙ NE 37 *d.* 0 *m.*	2	6	2	0	1	1
W the 21 ⊙ NE 79 *d.* 0′.	2	6	54	0	0	32
X the 22 ⊙ NE 37 *d.* 0 *m.*	2	7	32	0	0	38
Y the 23 ⊙ N W 20 *d.* 0′.	3	1	0	0	1	8
Z the 24 ⊙ NE 20 *d.* 0′.	3	1	33	0	0	33
Q the 25 ⊙ SE 40 *d.* 0 *m.*	3	2	12	0	0	19
The cut River that goes to the *Powder-Mills* on *Eſſex*-ſide goes out of the River here, and runs almoſt ſtraight.						
2 the 26 ⊙ NE 14 *d.* 0′.	3	2	36	0	0	24
♄ the 27 ⊙ NW 49. *d.* 0′.	3	3	19	0	0	23
Hiam-Houſe on the Right, and the end of our Stations.	3	4	10			

The Protraction of the River is the ſame with the Road, therefore I need not trouble my ſelf with the repeating of one thing twice. I have protracted (for a Specimen) part of *Hackney*-River, *viz.* from *Jeremiah*'s Booth unto *Hiam*-Houſe, to a large Scale; by which Figure you may ſee the Nature of protracting any other River whatſoever. You may likewiſe ſee how true that River is laid down in all our County-Maps;

Maps; and I do likewise presume that all the other Rivers in our County-Maps are laid down after the same manner: which way they took the River I cannot tell, whether by perambulation, or by an actual Survey; however I can boldly say, there is not a County-Map of *Speed*'s nor *Saxton*'s (which is best) that hath the Rivers truly laid down in them.

CHAP. IX.

How to take the Plot of any County whatsoever by the Wheel and Semicircle.

IN taking a Plot of any County, these things are to be done.

First, All Churches are to be laid down according to their true Horizontal distance one from the other.

Secondly, All Rivers ought to be truly protracted in the said Map.

And Thirdly, All Roads, or the principal of them, should likewise be protracted with the same exactness as the Rivers are. All Parks and Forests must be truly laid down in the said Map, as to their Bounds and Situation: All Great Houses that have Names, ought likewise to be placed in the same, with the true distance from any place of Remark.

You are likewise to describe the quality of the County, whether it be Hilly or Woody; placing the Hills and Woods in their true places.

You must likewise describe the Sea-Coast exactly in

in those Counties that border upon the Sea, which as yet was never done.

You must likewise describe all Lakes of Water exactly, which likewise was never yet done. For the performing of these things, observe these Rules.

First, It will be convenient that you begin your Work at some noted Market Town, and from thence measure the Road exactly unto the second, and from the second to the third, and from the third unto the first, and all along as you measure the Road, take the Bearings to all Churches and other eminent places within sight of the Road.

Then protract the Road exactly upon the Paper or Velam that you are minded to have your County-Map drawn on, at any convenient place thereof; and by that means you will not only have the Towns that are in the Road exactly placed, but you will have likewise those Churches or other eminent Remarks on both sides of the same exactly laid down, as you measure along the Road. It will be convenient that you take your Semicircle up to the top of the Steeple of every Town you pass through, and take a Bearing to all the Churches that are within your sight, and by that means you may by protraction, if care be taken, find the true Horizontal distance of all the place that are within sight of the Road.

When you have performed so much of your work as you can in your measuring the Road through these three Market-Towns, then by some other old County-Map you may contrive 3 or 4 other Market-towns to measure through, as you did the other three; and so do until you have measured most or all the Roads that lead from Market-Town to Market-Town; and this very thing will set a great Essay towards the doing of any County-Map whatsoever.

The

The next thing that is to be done towards the completing of the Map is this; you must go and measure the main Rivers that run through that County, after the same manner as you are directed in the last Chapter; and by doing of this, you will place a great many more Churches and other Remarks in their true places; for those Counties that are Hilly, most of their Towns stand in Dales, near or within sight of the River. When the main River is done, all the Branches must be done with the like exactness; for the main Rivers and the Branches being done exactly, will be a great Ornament to a County-Map.

The Roads and Rivers being exactly surveyed and protracted of any County whatsoever, will be sufficient to make a Map thereof without any thing else.

Those that are minded to make a Map of any County by only taking the Horizontal Angles from Steeples or other places by having the true Horizontal distance of those two from which he takes his Angles, the Rules delivered in the 20th Chapter of the First Part are sufficient.

Note, When you measure along the Road for your County-Map, if you pass over a Hill that makes an Angle at the Base thereof above 5 deg. and the height thereof be above a Furlong, you must find the Horizontal Line of that Hill, and protract that, otherwise a great Error may ensue. The Rules given in the 19th Chapter of the First Part will serve to perform this Work; but becaufe some may think it too troublesom, I have annexed a Table which performs the Work with a great deal of ease; the use whereof follows in the next Chapter.

Any one may make a Map of a County by having the difference of Latitude and Longitude of Places from

the place of your first setting forth. This way if you take your Observations exactly, is the only way that can be to place Towns aright in your Map; for the performance of which, the Table that I have put for the finding of the Horizontal Line of any Hill will do this also; the use whereof for the finding the difference of Latitude and Longitude of any place from the place you first set forth, will be the subject matter of one whole Chapter.

CHAP. X.

The Use of the Table of Latitude and Longitude for the ready finding the Horizontal Line of any Hill.

BEing come to the Ascent of any Hill, place your Instrument at the foot of the same, and find what Angle the Brow of the Hill makes with the Foot thereof, after the same manner as you were taught in *Chap.* 19. of the First Part; then with your Wheel measure up to the Brow thereof, and note how many Poles there is, then enter the Table at the Head with the Angle of Observation, and in the Left hand Column thereof look for the Number of Poles, and against it in the Angle of meeting, you will have the length of the Horizontal Line in Poles and Tenths of a Pole.

Exampli:

Example.

Admit you were at the Aſcent of a Hill, and found by Obſervation the Angle to 25 deg. and the meaſured diſtance to be 50 Poles, turn to the Table, and under 25 deg. and againſt 50 poles, you find 453, and in the next Column you have 211; the 45, 3 doth ſhew that the Baſe Line of that Angle will be 45 Poles and three Tenths of a Pole: 21, 1 doth ſhew that the Brow of the Hill is 21 Poles and 1 Tenth above the Horizontal Line; this 45 Poles and 3 Tenths muſt be protracted, and not the 50 which you meaſured.

In the ſame manner muſt you do for a Deſcent; for ſtanding at the Brow of any Hill, there place your Inſtrument as you are directed in *Chap.* 19. of the Firſt Part, and take an Angle to ſome Mark at the Foot of the ſame; then meaſuring down to the ſame, look for the degrees of the Angle as you did for the Aſcent, and the length of the Hypothenuſal Line in the left hand Column, and againſt it, in the Angle of meeting, you will have the length of the Baſe and Perpendicular; the Baſe is the Horizontal Line, and the Perpendicular is the height of the Brow from the Horizontal Line.

Example.

Admit you were at the Deſcent of a Hill, and obſerved the Angle to be 50 deg. and the meaſured diſtance to be 100 Poles, look for 50 deg. at the Head of the Table, and for 100 in the Left hand Column, and at the Angle of meeting you will find 766 and

943;

643; this 766 is 76 Poles and 6 Tenths of a Pole, and is the length of the Horizontal Line; and the 643 is the length of the Perpendicular, or Height of the Brow from the Horizontal Line.

CHAP. XI.

How to find the Latitude and Longitude of any Place from the Place you first set forth; that is, how far any Place is to the North or South from the Place of first setting out, as also how far it is to the East or West.

FOrasmuch as the Roads lying between Place and Place, have many Turnings and Windings, you must find the Latitude and Longitude of every Station, and set them down in 4 Columns, *viz.* the Northing under the North; the Southing under the South; the Easting under the East; and the Westing under the West: and then if you substract the North and South, *viz.* the lesser out of the greater, the Remainder doth shew you how much the Place is to the North or South from the Place where you began your Observations; and by substracting the Easting and Westing one out of the other, the Remainer shews how far the Place is to the East or West from the Place you first began.

Examp

Example.

In the Road between *London* and *High-Gate*, beginning at the Pound in S. *Johns*-Street, the first Observation was NW 25 deg. 35 Poles: Look for 25 deg. at the head of the Table, and 35 in the Left hand Column thereof, and you will find in the Angle of meeting first 317 and 148; the 317 doth shew that your 2 Station is 31 Poles and 7 Tenths to the North of your first Station; and the 148 doth shew that your second Station is 14 Poles 8 Tenths of a Pole to the West of your first Station.

At the second Station you observed the Road to bear NE 32 deg. and you went upon that Course 22 Poles; look for 32 degrees in the Head of the Table, and for 22 Poles in the left hand Column of the same, and in the Angle of meeting you will have 187 and 117; the 187 doth shew that you are come 18 Poles 7 Tenths of a Pole to the North of your second Station, and the 117 doth shew that you are come 11 Poles and 7 Tenths of a Pole to the Eastward of your second Station. In this manner must you do in all the rest of the Observations.

Note, when your Variation is least, then 45 deg. of the North or South, the greatest Number that you find must be placed under the North or South Column, but if it doth exceed 45 deg. then the greatest Number found in the Table must be placed in the East or West Colums, in the same manner as you see in the following Table.

The Table of Easting, Westing, Northing and Southing of all the Observations taken in measuring between London *and* High-Gate.

The Stations.	Dist.	N.	S.	E.	W.
1 ⊙ NW 25 00	35	31.7			148
2 ⊙ NE 32 00	22	18.7		117	
3 ⊙ NW 9 00	34	33.6			053
4 ⊙ NE 7 00	35	34.7		43	
5 ⊙ NW 6 30	56	55.6½			58
6 ⊙ NW 5 00	19	19.0			17
7 ⊙ NE 29 30	90	78.0		443	
8 ⊙ NE 16 00	16	15.4		44	
9 ⊙ NE 9 00	17	16.8		26	
10 ⊙ NE 17 30	21	20.4		63	
11 ⊙ NW 00 30	173	173.0			31
12 ⊙ NW 43 00	69	43.9			409
13 ⊙ NW 34 30	94	77.4			532
14 ⊙ NW 36 00	262	212.0			1540
15 ⊙ NW 35 00	52	42.6			298
16 ⊙ NW 49 00	28	15.1			174
17 ⊙ NW 41 30	35	26.2			231
18 ⊙ NW 61 00	61	29.6			534
19 ⊙ NW 50 15	112	73.5			862
20 ⊙ NW 44 00	48	34.5			334
21 ⊙ NW 53 00	84	50.6			671
22 ⊙ NW 70 30	20	6.6			188
23 ⊙ NW 63 00	13	5.9			116
24 ⊙ NW 70 00	86	29.3			378
25 ⊙ NW 44 00	53	38.1			368
		1164.9		736	6902
					736
					6166

Her

Here you ſee that *High-Gate* is to the North of the Pound in S. *John*-Street 1164 poles and 9 Tenths of a pole, and it is likewiſe 616 poles and 6 Tenths of a pole to the Weſt of the ſame place. In this manner may you find the Latitude and Longitude of any place whatſoever, and ſo come to make a true Map of any County.

The Structure of theſe Tables is from this Ground.

As the Radius is in proportion to the diſtance between any two places, ſo is the Coſine of the Bearing of the Two Places to the Difference of Latitude. And ſo is the Sine of that Bearing to the Difference of the Longitude of thoſe two places.

Example.

High-Gate doth bear from the Pound in S. *John*-Street N W 27 deg. 53 min. and the neareſt diſtance is 1320 poles.

As the Radius	90 *d.*	10,000000
Is to the Log. of the Diſtance	1320.	3,120062
So is the Sine of	27,53.	9,669942
To the Log. of the Diff. of Long.	616.6	2,790004

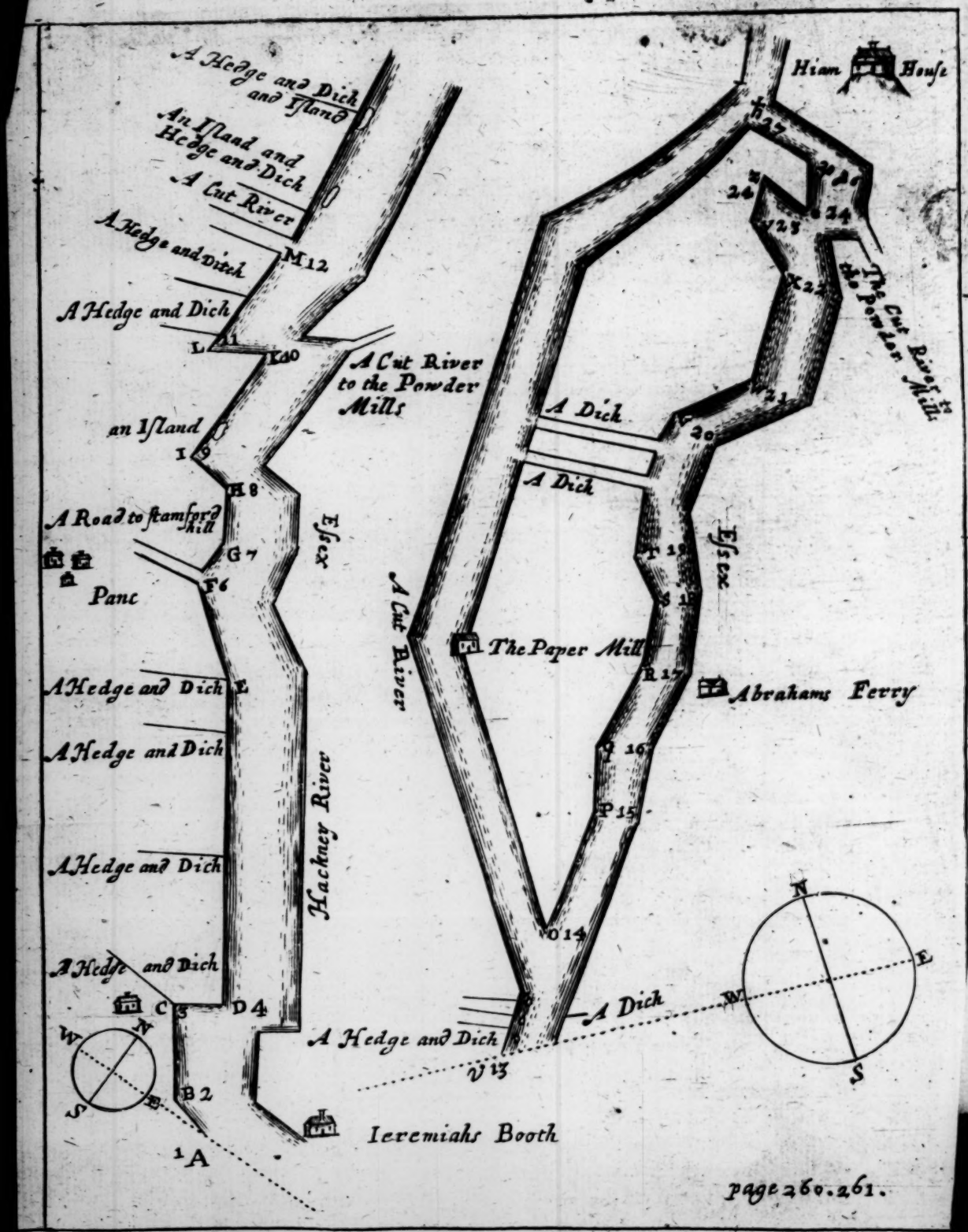
And ſo much is *High-Gate* to the Weſt of the Pound in S. *John*-Street.

For the Latitude.

As the Radius	90 *d.*	10,000000
Is to the Diſtance	1320	3,120062
So is the Coſine of	27,53	9,946404
To the Difference of Latitude.	1164	3,066466

And so many Poles is *High-Gate* to the North of the Pound in S. *Johns*-Street. In this manner was this Table made; and if you have a desire to have it go larger, you may do it at your Leisure. However, at this time

Farewel.


A Hedge and Dich and Island
An Island and Hedge and Dich
A Cut River
A Hedge and Ditch
M 12
A Hedge and Dich
L 11
K 10
A Cut River to the Powder Mills
an Island
I 9
H 8
A Road to stamford hill
G 7
Panc
F 6
Essex
A Hedge and Dich
E
A Hedge and Dich
A Hedge and Dich
A Hedge and Dich
Hackney River
C 3
D 4
B 2
1 A
Ieremiahs Booth
Hiam House
h 27
24
24
23
X 22
The Cut River to the Powder Mills
21
A Dich
20
A Dich
T 19
S 18
Essex
A Cut River
The Paper Mill
R 17
Abrahams Ferry
Q 16
P 15
O 14
A Dich
A Hedge and Dich
V 13
N
E
W
S

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A TABLE for the finding the *Longitude* and *Latitude* of Places.

	1 d.	89 d.	2 d.	88 d.	3 d.	87 d.
1	10	0	10	0	10	1
2	20	0	20	1	20	1
3	30	0	30	1	30	1
4	40	1	40	1	40	2
5	50	1	50	2	50	2
6	60	1	60	2	60	3
7	70	1	70	2	70	4
8	80	1	80	3	80	4
9	90	2	90	3	90	5
10	100	2	100	3	100	5
11	110	2	110	4	110	6
12	120	2	120	4	120	6
13	130	2	130	4	130	7
14	140	2	140	5	140	7
15	150	3	150	5	150	8
16	160	3	160	6	160	8
17	170	3	170	6	170	9
18	180	3	180	6	180	9
19	190	3	190	7	190	10
20	200	4	200	7	200	10
30	300	5	300	10	300	16
40	400	7	400	14	400	21
50	500	9	500	17	500	26
60	600	11	600	21	599	31
70	700	12	700	24	699	37
80	800	14	800	28	799	42
90	900	16	899	31	899	47
100	1000	18	999	35	999	52
200	2000	35	1999	70	1997	105
300	3000	53	2998	105	2996	157

	4 d.	86 d.	5 d.	85 d.	6 d.	84 d.
1	10	1	10	1	10	1
2	20	1	20	2	20	2
3	30	2	30	3	30	3
4	40	3	40	3	40	4
5	50	3	50	4	50	5
6	60	4	60	5	60	6
7	70	5	70	6	70	7
8	80	6	80	7	80	8
9	90	6	90	8	89	9
10	100	7	100	9	99	10
11	110	8	110	10	109	11
12	120	8	120	10	119	12
13	130	9	130	11	129	14
14	140	10	140	12	139	15
15	150	10	150	13	149	16
16	160	11	160	14	159	17
17	170	12	170	15	169	18
18	180	13	180	16	179	19
19	190	13	190	17	189	20
20	200	14	200	17	199	21
30	299	21	299	26	298	31
40	399	28	398	35	398	42
50	499	35	498	44	497	52
60	599	42	598	52	797	63
70	698	49	697	61	696	73
80	798	56	797	70	796	83
90	898	63	897	78	895	94
100	998	70	996	87	995	104
200	1995	140	1992	174	1980	209
300	2993	209	2989	262	2983	313

	7 d.	83 d.	8 d.	82 d.	9 d.	81 d.
1	10	1	10	1	10	2
2	20	2	20	3	20	3
3	30	4	30	4	30	5
4	40	5	40	6	40	6
5	50	6	50	7	50	8
6	60	7	59	8	59	9
7	69	8	69	10	69	11
8	79	10	79	11	79	13
9	89	11	89	13	89	14
10	99	12	99	14	99	16
11	109	13	109	15	109	17
12	119	15	119	17	119	19
13	129	16	129	18	129	20
14	139	17	139	19	138	22
15	149	18	148	21	148	23
16	159	20	158	22	158	25
17	169	21	168	24	168	26
18	179	22	178	25	178	28
19	189	23	188	26	188	30
20	199	24	198	28	198	31
30	298	37	297	42	296	47
40	397	49	396	56	395	63
50	496	61	495	70	494	78
60	596	73	594	83	593	94
70	695	85	693	97	691	109
80	794	98	792	111	790	125
90	893	110	891	125	889	141
100	993	122	990	139	988	156
200	1985	244	1981	278	1975	313
300	2977	366	2971	418	2963	368

	10 d.	80 d.	11 d.	79 d.	12 d.	78 d.
1	10	2	10	2	10	2
2	20	3	20	4	20	4
3	30	5	29	6	29	6
4	39	7	39	8	39	8
5	49	9	49	9	49	10
6	59	10	59	11	59	12
7	69	12	69	13	69	15
8	79	14	78	15	78	17
9	89	16	88	17	88	19
10	99	17	98	19	98	21
11	108	19	108	21	108	23
12	118	21	118	23	117	25
13	128	23	128	25	127	27
14	138	24	137	27	137	29
15	148	26	147	29	147	31
16	158	28	157	30	156	33
17	168	30	167	32	166	36
18	17[illegible]	31	177	34	176	38
19	18[illegible]	33	186	36	186	40
20	197	35	196	38	196	42
30	296	52	294	57	293	62
40	394	69	393	76	391	83
50	492	87	491	95	489	104
60	591	104	589	114	587	125
70	689	121	687	134	685	146
80	788	139	785	153	783	166
90	886	156	883	172	880	187
100	985	174	981	191	978	206
200	1970	347	1963	382	1956	416
300	2954	521	2944	572	2934	624

	13 d.	77 d.	14 d.	76 d.	15 d.	75 d.
1	10	2	10	2	10	3
2	20	4	19	5	19	5
3	29	7	29	7	29	8
4	39	9	39	10	39	10
5	49	11	48	12	48	13
6	59	13	58	14	58	16
7	68	16	68	17	68	18
8	78	18	78	19	77	21
9	88	20	87	22	87	23
10	98	22	97	24	97	26
11	107	25	107	27	106	28
12	117	27	116	29	116	31
13	127	29	126	31	126	34
14	136	31	136	34	135	36
15	146	34	146	36	145	39
16	156	36	155	39	155	41
17	166	38	165	41	164	44
18	176	40	175	44	174	47
19	185	43	184	46	183	49
20	195	45	194	48	193	52
30	292	67	291	73	290	78
40	390	90	388	97	386	103
50	487	112	485	121	483	129
60	585	135	582	145	580	155
70	682	157	679	169	676	181
80	780	180	776	194	774	207
90	877	202	873	218	869	233
100	974	225	970	242	966	259
200	1949	450	1941	484	1932	518
300	2923	675	2911	726	2898	776

	16 d.	74 d.	17 d.	73 d.	18 d.	72 d.
1	10	3	10	3	10	3
2	19	6	19	6	19	6
3	29	8	29	9	28	9
4	38	11	38	12	38	12
5	48	14	48	15	47	15
6	58	17	57	17	57	18
7	67	19	67	20	66	22
8	77	22	76	23	76	25
9	86	25	86	26	85	28
10	96	28	96	29	95	31
11	106	30	105	32	104	34
12	115	33	115	35	114	37
13	125	36	124	38	123	40
14	134	39	134	41	133	43
15	144	41	143	44	142	46
16	154	44	153	47	152	50
17	163	47	162	50	161	53
18	173	50	172	52	171	56
19	183	53	182	55	180	59
20	192	55	191	58	190	62
30	288	83	287	88	285	93
40	384	110	383	117	380	124
50	481	138	478	146	476	154
60	577	165	574	175	571	185
70	673	193	669	205	666	216
80	769	220	765	234	761	247
90	865	248	861	263	856	278
100	961	276	956	292	951	309
200	1925	551	1913	585	1902	618
300	2884	827	2869	877	2850	927

	19 d.	71 d.	20 d.	70 d.	21 d.	69 d.
1	9	3	9	3	9	4
2	19	6	19	7	19	7
3	28	10	28	10	28	11
4	38	13	38	14	37	14
5	47	16	47	17	47	18
6	57	20	56	20	56	21
7	66	23	66	24	65	25
8	75	26	75	27	75	29
9	85	29	85	31	84	32
10	95	33	94	34	93	36
11	104	36	103	38	103	39
12	113	39	113	41	112	43
13	123	42	122	44	121	47
14	132	46	132	48	131	50
15	142	49	141	51	140	54
16	151	52	150	55	149	57
17	161	55	166	58	159	61
18	170	59	169	61	168	64
19	180	62	179	65	177	68
20	189	65	188	68	187	72
30	284	98	282	103	280	107
40	378	130	376	137	373	143
50	473	163	470	171	467	179
60	567	195	564	205	560	215
70	662	228	658	209	653	251
80	756	261	752	274	747	287
90	851	293	846	308	840	323
100	945	326	940	342	934	358
200	1891	651	1879	684	1867	717
300	2836	977	2819	1026	2801	1075

	22 d.	68 d.	23 d.	67 d.	24 d.	66 d.
1	9	4	9	4	9	4
2	19	7	18	8	18	8
3	28	11	28	12	27	12
4	37	15	37	16	36	16
5	46	19	46	19	46	20
6	56	22	55	23	55	24
7	65	26	64	27	64	28
8	74	30	74	31	73	32
9	83	34	83	35	82	37
10	93	37	92	39	91	41
11	102	41	101	43	100	45
12	111	45	110	47	109	49
13	120	49	120	51	119	53
14	130	52	129	55	128	57
15	139	56	138	59	137	61
16	148	60	147	62	146	65
17	157	64	156	66	155	69
18	167	67	166	70	164	73
19	176	71	175	74	173	77
20	185	75	184	78	183	81
30	278	112	276	117	274	122
40	371	150	368	156	365	163
50	464	187	460	195	457	203
60	556	225	552	234	548	244
70	647	262	644	273	639	285
80	742	300	736	312	731	325
90	834	337	828	352	822	366
100	927	375	920	391	913	407
200	1854	749	1841	781	1827	813
300	2782	1094	2761	1172	2746	1220

25 d.	65 d.	26 d.	64 d.	27 d.	63 d.
1 9	4	9	4	9	1 5
2 18	8	18	9	18	2 9
3 27	13	27	13	27	4 14
4 36	17	36	18	36	5 18
5 45	21	45	22	45	6 23
6 54	25	54	26	53	7 27
7 63	30	63	31	62	8 32
8 72	34	72	35	71	9 36
9 81	38	81	39	80	10 41
10 91	42	90	44	89	11 45
11 100	47	99	48	98	12 50
12 119	51	108	53	107	13 54
13 118	55	117	57	116	14 59
14 127	59	126	61	125	15 63
15 136	63	135	66	134	16 68
16 145	68	144	70	143	17 72
17 154	72	153	74	151	18 77
18 163	76	162	79	160	19 81
19 172	80	171	83	169	20 86
20 181	84	180	88	178	21 90
30 272	127	270	131	267	32 136
40 362	169	360	175	356	43 182
50 453	211	449	219	445	54 227
60 544	254	539	263	535	65 272
70 634	296	629	307	624	76 318
80 725	338	719	351	713	86 368
90 816	380	809	394	802	97 409
100 906	423	899	438	891	108 454
200 1813	845	1798	877	1782	217 909
300 2719	1268	2696	1315	2673	326 1363

	28 d.	62 d.	29 d.	61 d.	30 d.	60 d.
1	9	5	9	5	9	5
2	18	9	17	10	17	10
3	26	14	26	14	26	15
4	35	19	35	19	35	20
5	44	23	44	24	43	25
6	53	28	52	29	52	30
7	62	33	61	34	61	35
8	71	37	70	39	69	40
9	79	42	79	43	78	45
10	88	47	87	48	87	50
11	97	52	96	53	95	55
12	106	56	105	58	104	60
13	115	61	114	63	113	65
14	124	66	122	68	121	70
15	132	70	131	73	130	75
16	141	75	140	77	139	80
17	150	80	149	82	147	85
18	159	84	157	87	156	90
19	168	89	166	92	165	95
20	177	94	175	97	173	100
30	265	141	262	145	260	150
40	353	188	350	194	346	200
50	441	235	437	242	433	250
60	530	282	525	291	520	300
70	618	326	612	339	606	350
80	706	376	700	388	693	400
90	795	422	787	436	779	450
100	883	469	875	485	866	500
200	1766	939	1749	970	1732	1000
300	2649	1408	2624	1454	2598	1500

	31 d.	59 d.	32 d.	58 d.	33 d.	57 d.
1	9	5	8	5	8	5
2	17	10	17	11	17	11
3	26	15	25	16	25	16
4	34	21	34	21	34	22
5	43	26	42	26	42	27
6	51	31	51	32	50	33
7	60	36	59	37	59	38
8	69	41	68	42	67	44
9	77	46	76	48	76	49
10	86	51	85	53	84	54
11	94	57	93	58	92	60
12	103	62	102	64	101	65
13	111	67	110	69	109	71
14	120	72	119	74	117	76
15	129	77	127	79	126	82
16	137	82	136	85	134	87
17	146	88	144	90	143	93
18	154	93	153	95	151	98
19	163	98	161	101	159	104
20	171	103	170	106	168	109
30	257	154	254	159	252	163
40	343	206	339	212	335	218
50	429	257	424	265	419	272
60	514	309	509	318	503	327
70	600	360	594	371	587	381
80	686	412	678	424	671	436
90	771	463	763	477	755	490
100	857	515	848	530	839	545
200	1714	1030	1696	1060	1677	1089
300	2572	1545	2544	1590	1516	1634

	34 d.	56 d.	35 d.	55 d.	36 d.	54 d
1	8	6	8	6	8	6
2	17	11	17	11	16	12
3	25	17	25	17	24	18
4	33	22	33	23	32	23
5	41	28	41	29	40	29
6	50	34	49	34	48	35
7	58	39	57	40	56	41
8	66	45	66	46	64	47
9	75	50	74	52	72	53
10	83	56	82	57	81	59
11	91	61	90	63	89	65
12	99	67	98	69	97	70
13	108	73	106	75	105	76
14	116	78	115	80	113	82
15	124	84	123	86	121	88
16	133	89	131	92	129	94
17	141	95	139	98	138	100
18	149	101	147	103	146	106
19	158	106	156	109	154	112
20	166	112	164	115	162	118
30	249	168	246	172	243	176
40	332	224	328	229	324	235
50	414	280	410	287	404	294
60	497	335	491	344	485	353
70	580	391	573	402	566	411
80	663	447	655	459	647	470
90	746	503	737	516	728	529
100	829	559	819	574	809	588
200	1658	1119	1638	1174	1618	1176
300	2487	1678	2458	1721	2426	1763

	37 d.	53 d.	38 d.	52 d.	39 d.	51 d.
1	8	6	8	6	8	6
2	16	12	16	12	16	13
3	24	18	24	18	23	19
4	32	24	31	25	31	25
5	40	30	39	31	39	31
6	48	36	47	37	47	38
7	56	42	55	43	54	44
8	64	48	63	49	62	50
9	72	54	71	55	70	57
10	80	60	79	62	78	63
11	88	66	87	68	85	69
12	96	72	95	74	93	75
13	104	78	102	80	101	82
14	112	84	110	86	109	88
15	120	90	118	92	116	94
16	128	96	126	99	124	101
17	136	102	134	105	132	107
18	144	108	142	111	140	113
19	152	114	150	117	148	119
20	160	120	158	123	155	126
30	240	180	236	185	233	189
40	319	241	315	246	311	252
50	399	301	394	308	388	315
60	479	361	473	369	466	378
70	559	421	552	431	544	440
80	639	481	630	493	622	503
90	719	542	709	554	699	566
100	799	602	788	616	777	629
200	1597	1204	1576	1231	1554	1259
300	2396	1805	2364	1847	2331	1888

	40 d.	50 d.	41 d.	49 d.	42 d.	48 d.
1	8	6	8	7	7	7
2	15	13	15	13	15	13
3	23	19	23	20	22	20
4	31	26	30	26	30	27
5	38	32	38	33	37	33
6	46	38	45	39	44	40
7	54	45	53	46	52	47
8	61	51	60	52	59	53
9	69	58	68	59	67	60
10	77	64	75	66	74	67
11	84	71	83	72	82	73
12	92	77	91	79	89	80
13	100	83	98	85	97	87
14	107	90	106	92	104	93
15	115	96	113	98	111	100
16	123	103	121	105	119	107
17	130	109	128	112	126	113
18	138	116	136	118	134	120
19	146	122	143	125	141	127
20	153	129	151	131	149	134
30	230	193	226	197	223	201
40	306	257	302	262	297	268
50	383	321	377	328	372	335
60	460	386	453	394	446	401
70	536	450	528	459	520	468
80	613	514	604	525	594	535
90	689	579	679	590	669	602
100	765	943	755	656	743	669
200	1532	1286	1509	1312	1486	1338
300	2298	1928	2264	1968	2229	2007

	43 d.	47 d.	44 d.	46 d.	45 d.	45 d.
1	7	7	7	7	7	7
2	15	14	14	14	14	14
3	22	20	22	21	21	21
4	29	27	29	28	28	28
5	36	34	36	35	35	35
6	44	41	43	42	42	42
7	51	48	50	49	49	49
8	58	54	58	56	56	56
9	66	61	65	62	64	64
10	73	68	72	69	71	71
11	80	75	79	76	70	78
12	88	82	86	83	85	85
13	95	89	93	90	92	92
14	102	95	101	97	99	99
15	110	102	108	104	106	106
16	117	109	115	111	113	113
17	124	116	122	118	123	123
18	132	123	129	125	127	127
19	139	130	137	132	134	134
20	146	136	144	139	141	141
30	219	205	216	208	212	212
40	292	273	288	278	283	283
50	366	341	360	347	353	353
60	439	409	432	417	424	424
70	512	477	503	486	495	495
80	585	546	575	556	566	566
90	658	614	647	625	636	636
100	731	682	719	695	707	707
200	1463	1364	1439	1389	1414	1414
300	2194	2046	2158	2084	2121	2121

A Logarithmetical

CANON

OF

Sines and *Tangents* to every *Degree* and Five *Minutes* of the

QUADRANT,

The Common *Radius* being 10,000000.

0.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	0.000000	10.000000	0.000000	Infinita.	60
5	7.162696	10.000000	7.162696	12.837304	55
10	7.463726	9.999998	7.463727	12.536273	50
15	7.639816	9.999996	7.639820	12.360180	45
20	7.764754	9.999993	7.764761	12.235239	40
25	7.861662	9.999989	7.861674	12.138326	35
30	7.940842	9.999983	7.940858	12.059142	30
35	8.007787	9.999977	7.007809	11.992191	25
40	8.065776	9.999971	8.065806	11.934194	20
45	8.116926	9.999963	8.116963	11.883037	15
50	8.162681	9.999954	8.162737	11.837273	10
55	8.204070	9.999944	8.204126	11.795874	5
60	8.241855	9.999934	8.241921	11.758079	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

89.

1.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.241855	9.999934	8.241921	11.758079	60
5	8.276614	9.999922	8.276691	11.723309	55
10	8.308794	9.999910	8.308884	11.691116	50
15	8.338753	9.999897	8.338856	11.661144	45
20	8.366777	9.999882	8.366895	11.633105	40
25	8.393101	9.999867	8.393234	11.606766	35
30	8.417919	9.999851	8.418068	11.581932	30
35	8.441394	9.999834	8.441560	11.558440	25
40	8.463665	9.999816	8.463849	11.536151	20
45	8.484848	9.999797	8.485050	11.514950	15
50	8.505045	9.999778	8.505267	11.494733	10
55	8.524343	9.999757	8.524586	11.475414	5
60	8.542819	9.999735	8.543084	11.456916	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

88.

2.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.542819	9.999735	8.543084	11.456916	60
5	8.560540	9.999713	8.560828	11.439172	55
10	8.577566	9.999689	8.577877	11.422123	50
15	8.593948	9.999665	8.594283	11.405717	45
20	8.609734	9.999640	8.610094	11.389906	40
25	8.624965	9.999614	8.625352	11.374648	35
30	8.639680	9.999586	8.640093	11.359907	30
35	8.653911	9.999558	8.654352	11.345648	25
40	8.667689	9.999529	8.668160	11.331840	20
45	8.681043	9.999500	8.681544	11.318456	15
50	8 693998	9.999469	8.694529	11.305471	10
55	8.706577	9.999437	8.707140	11.292860	5
60	8.718800	9.999404	8.719396	11.280604	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

87.

3.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.718800	9.999404	8.719396	11.280604	60
5	8.730688	9.999371	8.731317	11.268683	55
10	8.742259	9.999336	8.742922	11.257078	50
15	8.753528	9.999301	8.754227	11.245773	45
20	8.764511	9.999265	8.765246	11.234754	40
25	8.775223	9.999227	8.775995	11.224005	35
30	8.785675	9.999189	8.786486	11.213514	30
35	8.795881	9.999150	8.796731	11.203269	25
40	8.805852	9.999110	8.806742	11.193258	20
45	8.815599	9.999069	8.816529	11.183471	15
50	8.825130	9.999027	8.826103	11.173897	10
55	8.834456	9.998984	8.835471	11.164529	5
60	8.843585	9.998941	8.844644	11.155356	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

86.

4.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.843585	9.998941	8.844644	11.155356	60
5	8.852525	9.998896	8.853628	11.146372	55
10	8.861283	9.998851	8.862433	11.137567	50
15	8.869868	9.998804	8.871064	11.128936	45
20	8.878285	9.998757	8.879529	11.120471	40
25	8.886542	9.998708	8.887833	11.112167	35
30	8.894643	9.998659	8.895984	11.104016	30
35	8.902596	9.998609	8.903987	11.096013	25
40	8.910404	9.998558	8.911846	11.088154	20
45	8.918073	9.998506	8.919568	11.080432	15
50	8.925609	9.998453	8.927156	11.072844	10
55	8.933015	9.998399	8.934616	11.065384	5
60	8.940296	9.998344	8.941952	11.058048	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

85.

5.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	8.940296	9.998344	8.941952	11.058048	60
5	8.947456	9.998289	8.949168	11.050832	55
10	8.954499	9.998232	8.956267	11.043733	50
15	8.961429	9.998174	8.963255	11.036745	45
20	8.968249	9.998116	8.970133	11.029867	40
25	8.974962	9.998056	8.976906	11.023094	35
30	8.981573	9.997996	8.983577	11.016423	30
35	8.988083	9.997935	8.990149	11.009851	25
40	8.994497	9.997872	8.996624	11.003376	20
45	9.000816	9.997809	9.003007	10.996993	15
50	9.007044	9.997745	9.009298	10.990702	10
55	9.013182	9.997680	9.015502	10.984498	5
60	9.019235	9.997614	9.021620	10.978380	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

84.

6.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.019235	9.997614	9.021620	10.978380	60
5	9.025203	9.997547	9.027655	10.972345	55
10	9.031089	9.997480	9.033609	10.966391	50
15	9.036896	9.997411	9.039485	10.960515	45
20	9.042625	9.997341	9.045284	10.954716	40
25	9.048279	9.997271	9.051008	10.948992	35
30	9.053859	9.997199	9.056659	10.943341	30
35	9.059367	9.997127	9.062240	10.937760	25
40	9.064806	9.997053	9.067752	10.932248	20
45	9.070176	9.996979	9.073197	10.926803	15
50	9.075480	9.996904	9.078576	10.921424	10
55	9.080719	9.996828	9.083891	10.916109	5
60	9.085894	9.996751	9.089144	10.910856	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

83.

7.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.085894	9.996751	9.089144	10.910856	60
5	9.091008	9.996673	9.094336	10.905664	55
10	9.096062	9.996594	9.099468	10.900532	50
15	9.101056	9.996514	9.104542	10.895458	45
20	9.105992	9.996433	9.109559	10.890441	40
25	9.110873	9.996351	9.114521	10.885479	35
30	9.115698	9.996269	9.119429	10.880571	30
35	9.120469	9.996185	9.124284	10.875716	25
40	9.125187	9.996100	9.129087	10.870913	20
45	9.129854	9.996015	9.133839	10.866161	15
50	9.134470	9.995928	9.138542	10.861458	10
55	9.139037	9.995841	9.143196	10.856804	5
60	9.143555	9.995753	9.147803	10.852197	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

82.

8.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.143555	9.995753	9.147803	10.852197	60
5	9.148026	9.995664	9.152363	10.847637	55
10	9.152451	9.995573	9.156877	10.843123	50
15	9.156830	9.995482	9.161347	10.838653	45
20	9.161164	9.995390	9.165774	10.834226	40
25	9.165454	9.995297	9.170157	10.829843	35
30	9.169702	9.995203	9.174499	10.825501	30
35	9.173908	9.995108	9.178799	10.821201	25
40	9.178072	9.995013	9.183059	10.816941	20
45	9.182196	9.904916	9.187280	10.812720	15
50	9.186280	9.994818	9.191462	10.808538	10
55	9.190325	9.994720	9.195606	10.804394	5
60	9.194332	9.994620	9.199713	10.800287	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

81.

9.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.194332	9.994620	9.199713	10.800287	60
5	9.198302	9.994159	9.203782	10.796218	55
10	9.202234	9.994418	9.207817	10.792183	50
15	9.206131	9.994316	9 211815	10.788185	45
20	9.209992	9.994212	9.215780	10.784220	40
25	9.213818	9.994108	9.219710	10.780290	35
30	9.217609	9.994003	9.223607	10.776393	30
35	9.221367	9.993897	9.227471	10.772529	25
40	9.225092	9.993789	9.231302	10.768698	20
45	9.228784	9.993681	9.235103	10.764897	15
50	9.232444	9.993572	9.238872	10.761128	10
55	9.236073	9.993462	9.242610	10.757390	5
60	9.239670	9 993351	9.246319	10.753681	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

80.

10.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.239670	9.993351	9.246319	10.753681	60
5	9.243237	9.993240	9.249998	10.750002	55
10	9.246775	9.993127	9.253648	10.746352	50
15	9.250282	9.993013	9.257269	10.742731	45
20	9.253761	9.992898	9.260863	10.739137	40
25	9.257211	9.992783	9.264428	10.735572	35
30	9.260633	9.992666	9.267967	10,732033	30
35	9.264027	9.992549	9.271479	10.728521	25
40	9.267395	9.992430	9.274964	10.725036	20
45	9.270735	9.992311	9.278424	10.721576	15
50	9 274049	9.992190	9.281858	10.718142	10
55	9.277337	9.992069	9.285268	10.714732	5
60	9.280599	9.991947	9.288652	10.711348	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

79.

11.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.280599	9.991974	9.288652	10.711348	60
5	9.283836	9.991823	9.292013	10.707987	55
10	9.287048	9.991699	9.295349	10.704651	50
15	9.290236	6.991574	9.298662	10.701338	45
20	9.293399	9.991448	9.301951	10.698049	40
25	9.296539	9.991321	9.305218	10.694782	35
30	9.299655	9.991193	9.308463	10.691537	30
35	9.302748	9.991064	9.311685	10.688315	25
40	9.305819	9.990934	9.314885	10.685115	20
45	9.308867	9.990803	9.318064	10.681936	15
50	9.311893	9.990671	9 321222	10.678778	10
55	9.314897	9.990538	9.324358	10.675642	5
60	9.317879	9.990404	9.327475	10.672525	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

78.

12.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.317879	9.990404	9.327475	10.672525	60
5	9.320840	9.990270	9.330570	10.669430	55
10	9.323780	9.990134	9.333646	10.666354	50
15	9.326700	9.989997	9.336702	10.663298	45
20	9.329599	9.989860	9.339739	10.660261	40
25	9.332478	9.989721	9.342757	10.657243	35
30	9.335337	9.989582	9.345755	10.654245	30
35	9.338176	9.989441	9.348735	10.651265	25
40	9.340996	9.989300	9.351697	10.648303	20
45	9.343797	9.989157	9.354640	10.645360	15
50	9.346579	9.989014	9.357566	10.642434	10
55	9.349343	9.988869	9.360474	10.639526	5
60	9.352088	9.988724	9.363364	10.636636	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

77.

13.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.352088	9.988724	9.363364	10.636636	60
5	9.354815	9.988578	9.366237	10.633763	55
10	9.357524	9.988430	9.369094	10.630906	50
15	9.360215	9.988282	9.371933	10.628067	45
20	9.362889	9.988133	9.374756	10.625244	40
25	9.365546	9.987983	9.377563	10.622437	35
30	9.368185	9.987832	9.380354	10.619646	30
35	9.370808	9.987679	9.383129	10.616871	25
40	9.373414	9.987526	9.385888	10.614112	20
45	9.376003	9.987372	9.388631	10.611369	15
50	9.378577	9.987217	9.391360	10.608640	10
55	9.381134	9.987061	9.394073	10.605927	5
60	9.383675	9.986904	9.396771	10.603229	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

76.

14.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.383675	9.986904	9.396771	10.603229	60
5	9.386201	9.986746	9.399455	10.600545	55
10	9.388711	9.986587	9.402124	10.597876	50
15	9.391206	9.986427	9.404778	10.595222	45
20	9.393685	9.986266	9.407419	10.592581	40
25	9.396150	9.986104	9.410045	10.589955	35
30	9.398600	9.985942	9.412658	10.587342	30
35	9.401035	9.985778	9.415257	10.584743	25
40	9.403455	9.985613	9.417842	10.582158	20
45	9.405862	9.985447	9.420415	10.579585	15
50	9.408254	9.985280	9.422974	10.577026	10
55	9.410632	9.985113	9.425519	10.574481	5
60	9.412996	9.984944	9.428052	10.571948	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

75.

15.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.412996	9.984944	9.428052	10.571948	60
5	9.415347	9.984774	9.430573	10.569427	55
10	9.417684	9.984603	9.433080	10.566920	50
15	9.420007	9.984432	9.435576	10.564424	45
20	9.422318	9.984259	9.438059	10.561941	40
25	9.424615	9.984085	9.440529	10.559471	35
30	9.426899	9.983911	9.442988	10.557012	30
35	9.429170	9.983735	9.445435	10.554565	25
40	9.431429	9.983558	9.447870	10.552130	20
45	9.433675	9.983381	9.450294	10.549706	15
50	9.435908	9.983202	9.452706	10.547294	10
55	9.438129	9.983022	9.455107	10.544893	5
60	9.440338	9.982842	9.457496	10.542504	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

74.

16.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.440338	9.982842	9.457496	10.542504	60
5	9.442535	9.982660	9.459875	10.540125	55
10	9.444720	9.982477	9.462242	10.537758	50
15	9.446893	9.982294	9.464599	10.535401	45
20	9.449054	9.982109	9.466945	10.533055	40
25	9.451204	9.981924	9.469280	10.530720	35
30	9.453342	9.981737	9.471605	10.528395	30
35	9.455469	9.981549	9.473919	10.526081	25
40	9.457584	9.981361	9.476223	10.523777	20
45	9.459688	9.981171	9.478517	10.521483	15
50	9.461782	9.980981	9.480801	10.519199	10
55	9.463864	9.980789	9.483075	10.516925	5
60	9.465935	9.980596	9.485339	10.514661	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

73.

17.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.465935	9.980596	9.485339	10.514661	60
5	9.467996	9.980403	9.487593	10.512407	55
10	9.470046	9.980208	9.489838	10.510162	50
15	9.472086	9.980012	9.492073	10.507927	45
20	9.474115	9.979816	9.494299	10.505701	40
25	9.476133	9.979618	9.496515	10.503485	35
30	9.478142	9.979420	9.498722	10.501278	30
35	9.480140	9.979220	9.500920	10.499080	25
40	9.482128	9.979019	9.503109	10.496891	20
45	9.484107	9.978817	9.505289	10.494711	15
50	9.486076	9.978615	9.507460	10.492540	10
55	9.488034	9.978411	9.509622	10.490378	5
60	9.489982	9.978206	9.511776	10.488224	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

72.

18.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.489982	9.978206	9.511776	10.488224	60
5	9.491922	9.978001	9.513921	10.486079	55
10	9.493851	9.977794	9.516057	10.483943	50
15	9.495772	9.977586	9.518186	10.481814	45
20	9.497682	9.977377	9.520305	10.479695	40
25	9.499584	9.977167	9.522417	10.477583	35
30	9.501476	9.976957	9.524520	10.475480	30
35	9.503360	9.976745	9.526615	10.473385	25
40	9.505234	9.976532	9.528702	10.471298	20
45	9.507099	9.976318	9.530781	10.469219	15
50	9.508956	9.976103	9.532853	10.467147	10
55	9.510803	9.975887	9.534916	10.465084	5
60	9.512642	9.975670	9.536972	10.463028	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

71.

19.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.512642	9.975670	9.536972	10.463028	60
5	9.514472	9.975452	9.539020	10.460980	55
10	9.516294	9.975233	9.541061	10.458939	50
15	9.518107	9.975013	9.543094	10.456906	45
20	9.519911	9.974792	9.545119	10.454881	40
25	9.521707	9.974570	9.547138	10.452862	35
30	9.523495	9.974347	9.549149	10.450851	30
35	9.525275	9.974122	9.551153	10.448847	25
40	9.527046	9.973897	9.553149	10.446851	20
45	9.528810	9.973671	9.555139	10.444861	15
50	9.530565	9.973444	9.557121	10.442879	10
55	9.532312	9.973215	9.559097	10.440903	5
60	9.534052	9.972986	9.561066	10.438934	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

70.

20.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.534052	9.972986	9.561066	10.438934	60
5	9.535783	9.972755	9.563028	10.436972	55
10	9.537507	9.972524	9.564983	10.435017	50
15	9.539223	9.972291	9.566932	10.433068	45
20	9.540931	9.972058	9.568873	10.431127	40
25	9.542632	9.971823	9.570809	10.429191	35
30	9.544325	9.971587	9.572738	10.427262	30
35	9.546011	9.971351	9.574660	10.425340	25
40	9.547689	9.971113	9.576576	10.423424	20
45	9.549360	9.970874	9.578486	10.421514	15
50	9.551024	9.970635	9.580389	10.419611	10
55	9.552680	9.970394	9.582286	10.417714	5
60	9.554329	9.970152	9.584177	10.415823	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

69.

21.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.554329	9.970152	9.584177	10.415823	60
5	9.555971	9.969909	9.586002	10.413938	55
10	9.557606	9.969665	9.587941	10.412059	50
15	9.559234	9.969420	9.589814	10.410186	45
20	9.560855	9.969173	9.591681	10.408319	40
25	9.562468	9.968926	9.593542	10.406458	35
30	9.564075	9.968678	9.595398	10.404602	30
35	9.565676	9.468429	9.597247	10.402753	25
40	9.567269	9.968178	9.599091	10.400909	20
45	9.568856	9.967927	9.600929	10.399071	15
50	9.570435	9.967674	9.602761	10.397239	10
55	9.572009	9.967421	9.604588	10.395412	5
60	9.573575	9.967166	9.606410	10.393590	0
	Co sine.	SIN.	Co-Tang	TAN.	M.

68.

22.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.573575	9.967166	9.606410	10.393590	60
5	9.575136	9.966910	9.608225	10.391775	55
10	9.576689	9.966653	9.610036	10.389964	50
15	9.578236	9.966395	9.611841	10.388159	45
20	9.579777	9.966136	9.613641	10.386359	40
25	9.581312	9.965876	9.615435	10.384565	35
30	9.582840	9.965615	9.617224	10.382776	30
35	9.584361	9.965353	9.619008	10.380992	25
40	9.585877	9.965090	9.620787	10.379213	20
45	9.587386	9.964826	9.622561	10.377439	15
50	9.588890	9.964560	9.624330	10.375670	10
55	9.590387	9.964294	9.626093	10.373907	5
60	9.591878	9.964026	9.627852	10.372148	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

67.

23.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.591878	9.964026	9.627852	10.372148	60
5	9.593303	9.963757	9.629606	10.370394	55
10	9.594842	9.963488	9.631355	10.368645	50
15	9.596315	9.963217	9.633099	10.366690	45
20	9.597783	9.962945	9.634838	10.365162	40
25	9.599244	9.962672	9.636572	10.363128	35
30	9.600700	9.962398	9.638302	10.361698	30
35	9.602150	9.962123	9.640027	10.359973	25
40	9.603594	9.961846	9.641747	10.358253	20
45	9.605032	9.961569	9.643463	10.356537	15
50	9.606465	9.961290	9.645174	10.354826	10
55	9.607892	9.961011	9.646881	10.353119	5
60	9.609313	9.960730	9.648583	10.351417	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

66.

24.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.609313	9.960730	9.648583	10.351417	60
5	9.610729	9.960448	9.650281	10.349719	55
10	9.612140	9.960165	9.651974	10.348026	50
15	9.613545	9.959882	9.653663	10.346337	45
20	9.614944	9.959596	9.655348	10.344652	40
25	9.616338	9.959310	9.657028	10.342972	35
30	9.617727	9.959023	9.658704	10.341296	30
35	9.619110	6.958734	9.660376	10.339624	25
40	9.620488	9.958445	9.662043	10.337957	20
45	9.621861	9.958154	9.663707	10.336293	15
50	9.623229	9.957863	9.665366	10.334634	10
55	9.624591	9.957570	9.667021	10.332979	5
60	9.625948	9.957276	9.668673	10.331327	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

65.

25.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.625948	9.957276	9.668673	1.0331327	60
5	9.627300	9.956981	9.670320	10.329680	55
10	9.628647	9.956684	9.671963	10.328037	50
15	9.629989	9.956387	9.673602	10.326398	45
20	9.631326	9.956089	9.675237	10.324763	40
25	9.632658	9.955789	9.676869	10.323131	35
30	9.633984	9.955488	9.678496	10.322504	30
35	9.635306	9.955186	9.680120	10.319880	25
40	9.636623	9.954883	9.681740	10.318260	20
45	9.637935	9.954579	9.683356	10.316644	15
50	9.639242	9.954274	9.684968	10.315032	10
55	9.640544	9.953968	9.686577	10.313423	5
60	9.641842	9.953660	9.688182	10.311818	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

64.

26.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.641842	9.953660	9.688182	10.311818	60
5	9.643135	9.953352	9.689783	10.310217	55
10	9.644423	9.953042	9.691381	10.308619	50
15	9.645706	9.952731	9.692975	10.307025	45
20	9.646984	9.952419	9.694566	10.305434	40
25	9.648258	9.952106	9.696153	10.303847	35
30	9.649527	9.951791	9.697736	10.302264	30
35	9.650792	9.951476	9.699316	10.300684	25
40	9.652052	9.951159	9.700893	10.299107	20
45	9.653308	9.950841	9.702781	10.297534	15
50	9.654558	9.950522	9.704036	10.295964	10
55	9.655805	9.950202	9.705603	10.294397	5
60	9.657047	9.949881	9.707166	10 292834	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

63.

27.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.657047	9.949881	9.707166	10.292834	60
5	9.658284	9.949558	9.708726	10.291274	55
10	9.659517	9.949235	2.710282	10.289718	50
15	9.660746	9.948910	9.711836	10.288104	45
20	9.661970	9.948584	9.713386	10.286614	40
25	9.663190	9.948257	9.714933	10.285067	35
30	9.664406	9.947929	9.716477	10.283523	30
35	9.665617	9.947600	9.718017	10.281983	25
40	9.666824	9.947269	9.719555	10.280445	20
45	9.668027	9.946937	9.721089	10.278911	15
50	9.669225	9.946604	9.722621	10.277379	10
55	9.670419	9.946270	9.724149	10.275851	5
60	9.671609	9.945935	9.725674	10.274326	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

62.

28.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.671609	9.945935	9.725674	10.274326	60
5	9.672795	9.945598	9.727197	10.272803	55
10	9.673977	9.945201	9.728716	10.271284	50
15	9.675155	9.944922	9.730233	10.269767	45
20	9.676328	9.944582	9.731746	10.268254	40
25	9.677498	9.944241	9.733257	10.266743	35
30	9.678663	9.943899	9.734764	10.265236	30
35	9.679824	9.943555	9.736269	10.263731	25
40	9.680982	9.943210	9.737771	10.262229	20
45	9.682135	9.942864	9.739271	10.260729	15
50	9.683284	9.942517	9.740767	10.259233	10
55	9.684430	9.942169	9.742261	10.257739	5
60	9.685571	9.941819	9.743752	10.256248	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

61.

29.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.685571	9.941819	9.743751	10.256248	60
5	9.686709	9.941469	9.745240	10.254760	55
10	9.687843	9.941117	9.746726	10.253274	50
15	9.688972	9.940763	9.748209	10.251791	45
20	9.690098	9.940409	9.749689	10.250311	40
25	9.691220	9.940054	9.751167	10.248833	35
30	9.692339	9.939697	9.752642	10.247358	30
35	9.693453	9.939339	9.754115	10.245885	25
40	9.694564	9.938980	9.755585	10.244415	20
45	9.695671	9.938619	9.757052	10.242948	15
50	9.696775	9.938258	9.758517	10.241483	10
55	9.697874	9.937895	9.759979	10.240021	5
60	9.698970	9.937531	9.761439	10.238561	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

60.

30.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.698970	9.937531	9.761439	10.238561	60
5	9.700062	9.937165	9.762897	10.237103	55
10	9.701151	9.936799	9.764352	10.235648	50
15	9.702236	9.936431	9.765805	10.234195	45
20	9.703317	9.936062	9.767255	10.232745	40
25	9.704395	9.935692	9.768703	10.231297	35
30	9.705469	9.935320	9.770148	10.229852	30
35	9.706539	9.934948	9.771592	10.228408	25
40	9.707606	9.934574	9.773033	10.226967	20
45	9.708670	9.934199	9.774471	10.225529	15
50	9.709730	9.933822	9.775908	10.224092	10
55	9.710786	9.933445	9.777342	10.222658	5
60	9.711839	9.933066	9.778774	10.221226	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

59.

31.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.711839	9.933066	9.778774	10.221226	60
5	9.712889	9.932685	9.780203	10.219797	55
10	9.713935	9.932304	9.781631	10.218369	50
15	9.714978	9.931921	9.783056	10.216944	45
20	9.716017	9.931537	9.784479	10.215521	40
25	9.717053	9.931152	9.785900	10.214100	35
30	9.718085	9.930766	9.787319	10.212681	30
35	9.719114	9.930378	9.788736	10.211264	25
40	9.720140	9.929989	9.790151	10.209849	20
45	9.721162	9.929599	9.791563	10.208437	15
50	9.722181	9.929207	9.792974	10.207026	10
55	9.723197	9.928815	9.794383	10.205617	5
60	9.724210	9.928420	9.795789	10.204211	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

58.

32.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.724210	9.928420	9.795789	10.204211	60
5	9.725219	9.928025	9.797194	10.202806	55
10	9.726225	9.927629	9.798596	10.201404	50
15	9.727228	9.927231	9.799997	10.200003	45
20	9.728227	9.926831	9.801396	10.198604	40
25	9.729223	9.926431	9.802792	10.197208	35
30	9.730217	9.926029	9.804187	10.195813	30
35	9.731206	9.925626	9.805580	10.194420	25
40	9.732193	9.925222	9.806971	10.193029	20
45	9.733177	9.924816	9.808361	10.191639	15
50	9.734157	9.924409	9.809748	10.190252	10
55	9.735135	9.924001	9.811134	10.188866	5
60	9.736109	9.923591	9.812517	10.187483	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

57.

33.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.736109	9.923591	9.812517	10.187483	60
5	9.737080	9.923181	9.813899	10.186101	55
10	9.738048	9.922769	9.815280	10.184720	50
15	9.739013	9.922355	9.816658	10.183342	45
20	9.739975	9.921940	9.818035	10.181965	40
25	9.740934	9.921524	9.819410	10.180590	35
30	9.741889	9.921107	9.820783	10.179217	30
35	9.742842	9.920688	9.822154	10.177846	25
40	9.743792	9.920268	9.823524	10.176476	20
45	9.744739	9.919846	9.824893	10.175107	15
50	9.745683	9.919424	9.826259	10.173741	10
55	9.746624	9.919000	9.827624	10.172376	5
60	9.747562	9.918574	9.828987	10.171013	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

56.

34.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.747562	9.918574	9.828987	10.171013	60
5	9.748497	9.918147	9.830349	10.169651	55
10	9.749429	9.917719	9.831709	10.168291	50
15	9.750358	9.917290	9.833068	10.166932	45
20	9.751284	9.916859	9.834425	10.165575	40
25	9.752208	9.916427	9.835780	10.164220	35
30	9.753128	9.915994	9.837134	10.162866	30
35	9.754046	9.915559	9.838487	10.161513	25
40	9.754960	9.915123	9.839838	10.160162	20
45	9.755872	9.914685	9.841187	10.158813	15
50	9.756782	9.914246	9.842535	10.157465	10
55	9.757688	9.913806	9.843882	10.156118	5
60	9.758591	9.913365	9.845227	10.154773	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

55.

35.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.758591	9.913365	9.845227	10.154773	60
5	9.759492	9.912922	9.846570	10.153430	55
10	9.760390	9.912477	9.847913	10.152087	50
15	9.761285	9.912031	9.849254	10.150746	45
20	9.762177	9.911584	9.850593	10.149407	40
25	9.763067	9.911136	9.851931	10.148069	35
30	9.763954	9.910686	9.853268	10.146732	30
35	9.764838	9.910235	9.854603	10.145397	25
40	9.765720	9.909782	9.855938	10.144062	20
45	9.766598	9.909328	9.857270	10.142730	15
50	9.767475	9.908873	9.858603	10.141398	10
55	9.768348	9.908416	9.859932	10.140068	5
60	9.769219	9.907958	9.861261	10.138739	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

54.

36.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.769219	9.907958	9.861261	10.138739	60
5	9.770087	9.907498	9.862589	10.137411	55
10	9.770952	9.907037	9.863915	10.136085	50
15	9.771815	9.906575	9.865240	10.134760	45
20	9.772675	9.906111	9.866564	10.133436	40
25	9.773533	9.905645	9.867887	10.132133	35
30	9.774388	9.905179	9.869209	10.130791	30
35	9.775240	9.904711	9.870529	10.129471	25
40	9.776090	9.904241	9.871849	10.128151	20
45	9.776937	9.903770	9.873167	10.126833	15
50	9.777781	9.903298	9.874484	10.125516	10
55	9.778624	9.902824	9.875800	10.124200	5
60	9.779463	9.902349	9.877114	10.122886	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

53.

37.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.779463	9.902349	9.877114	10.122886	60
5	9.780300	9.901872	9.878428	10.121572	55
10	9.781134	9.901394	9.879741	10.120259	50
15	9.781966	9.900914	9.881052	10.118948	45
20	9.782796	9.900433	9.882363	10.117637	40
25	9.783623	9.899951	9.883672	10.116328	35
30	9.784447	9.899467	9.884980	10.115020	30
35	9.785269	9.898981	9.886288	10.113712	25
40	9.786089	9.898494	9.887594	10.112406	20
45	9.786906	9.898006	9.888900	10.111100	15
50	9.787720	9.897516	9.890204	10.109796	10
55	9.788532	9.897025	9.891507	10.108493	5
60	9.789342	9.896532	9.892810	10.107190	0
	Co sine.	SIN.	Co-Tang.	TAN.	M.

52.

38.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.789342	9.896532	9.892810	10.107190	60
5	9.790149	9.896038	9.894111	10.105889	55
10	9.790954	9.895542	9.895412	10.104588	50
15	9.791757	9.895045	9.896712	10.103288	45
20	9.792557	9.894546	9.898010	10.101990	40
25	9.793354	9.894046	9.899308	10.100692	35
30	9.794150	9.893544	9.900605	10.099395	30
35	9.794942	9.893041	9.901901	10.098099	25
40	9.795733	9.892536	9.903197	10.096803	20
45	9.796521	9.892030	9.904491	10.095509	15
50	9.797307	9.891523	9.905785	10.094215	10
55	9.798091	9.891013	9.907077	10.092923	5
60	9.798872	9.890503	9.908369	10.091631	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

51.

39.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.798872	9.890503	9.908369	10.091631	60
5	9.799651	9.889990	9.909660	10.090340	55
10	9.800427	9.889477	9.910951	10.089049	50
15	9.801201	9.888961	9.912240	10.087760	45
20	9.801973	9.888444	9.913529	10.086471	40
25	9.802743	9.887926	9.914817	10.085183	35
30	9.803511	9.887406	9.916104	10.083895	30
35	9.804276	9.886885	9.917391	10.082609	25
40	9.805039	9.886362	9.918677	10.081323	20
45	9.805799	9.885837	9.919962	10.080038	15
50	9.806557	9.885311	9.921247	10.078753	10
55	9.807314	9.884783	9.922530	10.077470	5
60	9.808067	9.884254	9.923814	10.076186	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

50.

48.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.808067	9.884254	9.923814	10.076186	60
5	9.808819	9.883723	9.925096	10.074904	55
10	9.809569	9.883191	9.926378	10.073622	50
15	9.810316	9.882657	9.927659	10.072341	45
20	9.811061	9.882121	9.928940	10.071060	40
25	9.811804	9.881584	9.930220	10.069781	35
30	9.812544	9.881046	9.931499	10.068501	30
35	9.813283	9.880505	9.932778	10.067222	25
40	9.814019	9.879963	9.934056	10.065944	20
45	9.814753	9.879420	9.935333	10.064667	15
50	9.815485	9.878875	9.936611	10.063389	10
55	9.816215	9.878328	9.937887	10.062113	5
60	9.816943	9.877780	9.939163	10.060837	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

49.

41.

M.	SIN.	Co-sine	TAN.	Co-Tangent.	
0	9.816943	9.877780	9.939163	10.060837	60
5	9.817668	9.877230	9.940439	10.059561	55
10	9.818392	9.876678	9.941713	10.058287	50
15	9.819113	9.876125	9.942988	10.057012	45
20	9.819832	9.875571	9.944262	10.055738	40
25	9.820550	9.875014	9.945535	10.054465	35
30	9.821265	9.874456	9.946808	10.053192	30
35	9.821977	9.873896	9.948081	10.051919	25
40	9.822688	9.873335	9.949353	10.050647	20
45	9.823397	9.872772	9.950625	10.049375	15
50	9.824104	9.872208	9.951896	10.048104	10
55	9.824808	9.871641	9.953167	10.046833	5
60	9.825511	9.871073	9.954437	10.045563	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

48.

42.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.825511	9.871073	9.954437	10.045563	60
5	9.826211	9.870504	9.955708	10.044292	55
10	9.826910	9.869933	9.956977	10.043023	50
15	9.827606	9.869360	9.958247	10.041753	45
20	9.828301	9.868785	9.959516	10.040484	40
25	9.828993	9.868209	9.960784	10.039216	35
30	9.829683	9.867631	9.962052	10.037948	30
35	9.830372	9.867051	9.963320	10.036680	25
40	9.831058	9.866470	9.964588	10.035412	20
45	9.831742	9.865887	9.965855	10.034145	15
50	9.832425	9.865302	9.967123	10.032877	10
55	9.833105	9.864716	9.968389	10.031611	5
60	9.833783	9.864127	9.969656	10.030344	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M.

47.

43.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.833783	9.864127	9.969656	10.030344	60
5	9.834460	9.863538	9.970922	10.029078	55
10	9.835134	9.862946	9.972188	10.027812	50
15	9.835807	9.862353	9.973454	10.026546	45
20	9.836477	9.861758	9.974720	10.025280	40
25	9.837146	9.861161	9.975985	10.024015	35
30	9.837812	9.860562	9.977250	10.022750	30
35	9.838477	9.859962	9.978515	10.021485	25
40	9.839140	9.859360	9.979780	10.020220	20
45	9.839800	9.858756	9.981044	10.018956	15
50	9.840459	9.858151	9.982309	10.017691	10
55	9.841116	9.857543	9.983573	10.016427	5
60	9.841771	9.856934	9.984837	10.015163	0
	Co-sine	SIN.	Co-Tang.	TAN.	M.

46.

44.

M.	SIN.	Co-sine.	TAN.	Co-Tangent.	
0	9.841771	9.856934	9.984837	10.015162	60
5	9.842424	9.856323	9.986101	10.013899	55
10	9.843076	9.855711	9.987365	10.012635	50
15	9.843725	9.855096	9.988629	10.011371	45
20	9.844372	9.854480	9.989893	10.010107	40
25	9.845018	9.853862	9.991156	10.008844	35
30	9.845662	9.853242	9.992420	10.007580	30
35	9.846304	9.852620	9.993683	10.006317	25
40	9.846944	9.851997	9.994947	10.005053	20
45	9.847582	9.851372	9.996210	10.003790	15
50	9.848218	9.850745	9.997473	10.002527	10
55	9.848852	9.850116	9.998737	10.001263	5
60	9.849485	9.849485	10.000000	10 000000	0
	Co-sine.	SIN.	Co-Tang.	TAN.	M

45.

A Table

A

TABLE

OF

LOGARITHM NUMBERS,

From One to a Thouſand:

WHEREBY

The *Logarithm* of any Number under 1000 may be readily diſcovered.

N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.000000	41	1.612784	81	1.908485	121	2.082785
2	0.301030	42	1.623249	82	1.913814	122	2.086359
3	0.477121	43	1.633468	83	1.919078	123	2.089905
4	0.602060	44	1.643452	84	1.924279	124	2.093422
5	0.698970	45	1.653212	85	1.929419	125	2.096910
6	0.778151	46	1.662758	86	1.934498	126	2.100371
7	0.845098	47	1.672098	87	1.939519	127	2.103804
8	0.903090	48	1.681241	88	1.944482	128	2.107209
9	0.954242	49	1.690196	89	1.949390	129	2.110589
10	1.000000	50	1.698970	90	1.954242	130	2.113943
11	1.041393	51	1.707570	91	1.959041	131	2.117271
12	1.079181	52	1.716003	92	1.963788	132	2.120574
13	1.113943	53	1.724276	93	1.968483	133	2.123852
14	1.146128	54	1.732394	94	1.973128	134	2.127105
15	1.176091	55	1.740362	95	1.977723	135	2.130334
16	1.204120	56	1.748188	96	1.982271	136	2.133539
17	1.230449	57	1.755875	97	1.986772	137	2.136721
18	1.255272	58	1.763428	98	1.991226	138	2.139879
19	1.278753	59	1.770852	99	1.995635	139	2.143015
20	1.301030	60	1.778151	100	2.000000	140	2.146128
21	1.322219	61	1.785330	101	2.004321	141	2.149219
22	1.342422	62	1.792391	102	2.008600	142	2.152288
23	1.361728	63	1.799340	103	2.012837	143	2.155336
24	1.380211	64	1.806180	104	2.017033	144	2.158362
25	1.397940	65	1.812913	105	2.021189	145	2.161368
26	1.414973	66	1.819544	106	2.025306	146	2.164353
27	1.431364	67	1.826075	107	2.029384	147	2.167317
28	1.447158	68	1.832509	108	2.033424	148	2.170262
29	1.462398	69	1.838849	109	2.037426	149	2.173186
30	1.477121	70	1.845098	110	2.041393	150	2.176091
31	1.491361	71	1.851258	111	2.045323	151	2.178977
32	1.505150	72	1.857332	112	2.049218	152	2.181844
33	1.518514	73	1.863323	113	2.053078	153	2.184691
34	1.531479	74	1.869232	114	2.056905	154	2.187521
35	1.544068	75	1.875061	115	2.060698	155	2.190332
36	1.556303	76	1.880813	116	2.064458	156	2.193125
37	1.568202	77	1.886491	117	2.068186	157	2.195899
38	1.579783	78	1.892094	118	2.071882	158	2.198657
39	1.591064	79	1.897627	119	2.075547	159	2.201397
40	1.602060	80	1.903090	120	2.079181	160	2.204119

N.	Log.	N.	Log.	N.	Log.	N.	Log.
161	2.206826	201	2.303196	241	2.382017	281	2.448706
162	2.209515	202	2.305351	242	2.383815	282	2.450249
163	2.212187	203	2.307496	243	2.385606	283	2.451786
164	2.214844	204	2.309630	244	2.387389	284	2.453318
165	2.217484	205	2.311754	245	2.389166	285	2.454845
166	2.220108	206	2.313867	246	2.390935	286	2.456366
167	2.222716	207	2.315970	247	2.392697	287	2.457889
168	2.225309	208	2.318063	248	2.394452	288	2.459392
169	2.227887	209	2.320146	249	2.396199	289	2.460898
170	2.230449	210	2.322219	250	2.397940	290	2.462398
171	2.232996	211	2.324282	251	2.399674	291	2.463893
172	2.235528	212	2.326336	252	2.401401	292	2.465383
173	2.238046	213	2.328379	253	2.403121	293	2.466868
174	2.240549	214	2.330414	254	2.404834	294	2.468347
175	2.243038	215	2.332438	255	2.406540	295	2.469822
176	2.245513	216	2.334454	256	2.408239	296	2.471292
177	2.247973	217	2.336459	257	2.409933	297	2.472756
178	2.250420	218	2.338456	258	2.411619	298	2.474216
179	2.252853	219	2.340444	259	2.413299	299	2.475671
180	2.255273	220	2.342422	260	2.414973	300	2.477121
181	2.257679	221	2.344392	261	2.416641	301	2.478566
182	2.260071	222	2.346353	262	2.418301	302	2.480007
183	2.262451	223	2.348305	263	2.419956	303	2.481443
184	2.264818	224	2.350248	264	2.421604	304	2.482874
185	2.267172	225	2.352183	265	2.423246	305	2.484299
186	2.269513	226	2.354108	266	2.424882	306	2.485721
187	2.271842	227	2.356026	267	2.426511	307	2.487138
188	2.274158	228	2.357935	268	2.428135	308	2.488551
189	2.276462	229	2.359835	269	2.429752	309	2.489958
190	2.278754	230	2.361728	270	2.421364	310	2.491362
191	2.281033	231	2.363612	271	2.432969	311	2.492760
192	2.283301	232	2.365488	272	2.434569	312	2.494155
193	2.285557	233	2.367356	273	2.436163	313	2.495544
194	2.287802	234	2.369216	274	2.437751	314	2.496929
195	2.290035	235	2.371068	275	2.439333	315	2.498311
196	2.292256	236	2.372912	276	2.440909	316	2.499687
197	2.294466	237	2.374748	277	2.442479	317	2.501059
198	2.296665	238	2.376577	278	2.444045	318	2.502427
199	2.298853	239	2.378398	279	2.445604	319	2.503791
200	2.301029	240	2.380211	280	2.447158	320	2.505149

N.	Log.	N.	Log.	N.	Log.	N.	Log.
321	2.506505	361	2.557507	401	2.603144	441	2.644439
322	2.507856	362	2.558709	402	2.604226	442	2.645422
323	2.509203	363	2.559907	403	2.605305	443	2.646404
324	2.510545	364	2.501101	404	2.606381	444	2.647383
325	2.511883	365	2.562293	405	2.607455	445	2.648360
326	2.513218	366	2.563481	406	2.608526	446	2.649335
327	2.514548	367	2.564666	407	2.609594	447	2.650308
328	2.515874	368	2.565848	408	2.610660	448	2.651278
329	2.517196	369	2.567026	409	2.611723	449	2.652246
330	2.518514	370	2.568202	410	2.612784	450	2.653213
331	2.519828	371	2.569374	411	2.613842	451	2.654177
332	2.521138	372	2.570543	412	2.614897	452	2.655138
333	2.522444	373	2.571709	413	2.615950	453	2.656098
334	2.523746	374	2.572872	414	2.617000	454	2.657056
335	2.525045	375	2.574031	415	2.618048	455	2.658011
336	2.526339	376	2.575188	416	2.619093	456	2.658965
337	2.527629	377	2.576341	417	2.620136	457	2.659916
338	2.528916	378	2.577492	418	2.621176	458	2.66.865
339	2.530199	379	2.578639	419	2.622214	459	2.661813
340	2.531479	380	2.579784	420	2.623249	460	2.662758
341	2.532754	381	2.580925	421	2.624282	461	2.663701
342	2.534026	382	2.582063	422	2.625312	462	2.664642
343	2.535294	383	2.583199	423	2.626340	463	2.665581
344	2.536558	384	2.584331	424	2.627366	464	2.666,18
345	2.537819	385	2.585461	425	2.628389	465	2.667453
346	2.539076	386	2.586587	426	2.629409	466	2.668386
347	2.540329	387	2.587711	427	2.630428	467	2.669317
348	2.541579	388	2.588832	428	2.631444	468	2.670246
349	2.542825	389	2.589949	429	2.632457	469	2.671173
350	2.544008	390	2.591065	430	2.633468	470	2.672098
351	2.545307	391	2.592177	431	2.634477	471	2.673021
352	2.546543	392	2.593286	432	2.635484	472	2.673942
353	2.547775	393	2.594393	433	2.636488	473	2.674861
354	2.549003	394	2.595496	434	2.637489	474	2.675778
355	2.550228	395	2.596597	435	2.638489	475	2.676694
356	2.551449	396	2.597695	436	2.639486	476	2.677607
357	2.552668	397	2.598790	437	2.640481	477	2.678518
358	2.553883	398	2.599883	438	2.641475	478	2.679428
359	2.555094	399	2.600973	439	2.642465	479	2.680336
36	2.556303	400	2.602059	440	2.643453	48(	2.681241

N.	Log.	N.	Log.	N.	Log.	N.	Log.
481	2.682145	521	2.716838	561	2.748963	601	2.778874
482	2.683047	522	2.717671	562	2.749736	602	2.779596
483	2.683947	523	2.718502	563	2.750508	603	2.780317
484	2.684845	524	2.719331	564	2.751279	604	2.781037
485	2.685742	525	2.720159	565	2.752048	605	2.781755
486	2.686636	526	2.720986	566	2.752816	606	2.782473
487	2.687529	527	2.721811	567	2.753583	607	2.783189
488	2.688419	528	2.722634	568	2.754348	608	2.783904
489	2.689309	529	2.723456	569	2.755112	609	2.784617
490	2.690196	530	2.724276	570	2.755875	610	2.785329
491	2.691081	531	2.725095	571	2.756636	611	2.786041
492	2.691965	532	2.725912	572	2.757396	612	2.786751
493	2.692847	533	2.726727	573	2.758155	613	2.787460
494	2.693727	534	2.727541	574	2.758912	614	2.788164
495	2.694605	535	2.728354	575	2.759668	615	2.788875
496	2.695482	536	2.729165	576	2.760422	616	2.789581
497	2.696356	537	2.729974	577	2.761176	617	2.790285
498	2.697229	538	2.730782	578	2.761928	618	2.790988
499	2.698101	539	2.731589	579	2.762679	619	2.791691
500	2.698970	540	2.732394	580	2.763428	620	2.792392
501	2.699838	541	2.733197	581	2.764176	621	2.793092
502	2.700704	542	2.733999	582	2.764923	622	2.793791
503	2.701568	543	2.734799	583	2.765669	623	2.794488
504	2.702430	544	2.735599	584	2.766413	624	2.795185
505	2.703291	545	2.736397	585	2.767156	625	2.795880
506	2.704151	546	2.737192	586	2.767898	626	2.796574
507	2.705008	547	2.737987	587	2.768638	627	2.797268
508	2.705863	548	2.738781	588	2.769377	628	2.797959
509	2.706718	549	2.739572	589	2.770115	629	2.798651
510	2.707570	550	2.740363	590	2.770852	630	2.799341
511	2.708421	551	2.741152	591	2.771587	631	2.800029
512	2.709269	552	2.741939	592	2.772322	632	2.800717
513	2.710117	553	2.742725	593	2.773055	633	2.801404
514	2.710963	554	2.743509	594	2.773786	634	2.802089
515	2.711807	555	2.744293	595	2.874517	635	2.802774
516	2.712649	556	2.745075	596	2.775246	636	2.803457
517	2.713491	557	2.745855	597	2.775974	637	2.804139
518	2.714329	558	2.746634	598	2.776701	638	2.804821
519	2.715167	559	2.747412	599	2.777427	639	2.805501
520	2.716003	560	2.748188	600	2.778151	640	2.806179

N.	Log.	N.	Log.	N.	Log.	N.	Log.
641	2.806858	681	2.833147	721	2.857935	761	2.881385
642	2.807535	682	2.833784	722	2.858537	762	2.881955
643	2.808211	683	2.834421	723	2.859138	763	2.882525
644	2.808886	684	2.835056	724	2.859739	764	2.883093
645	2.809559	685	2.835691	725	2.860338	765	2.883661
646	2.810233	686	2.836324	726	2.860937	766	2.884229
647	2.810904	687	2.836957	727	2.861534	767	2.884795
648	2.811575	688	2.837588	728	2.862131	768	2.885361
649	2.812245	689	2.838219	729	2.862728	769	2.885926
650	2.812913	690	2.838849	730	2.863323	770	2.886491
651	2.813581	691	2.839478	731	2.863917	771	2.887054
652	2.814248	692	2.840106	732	2.864511	772	2.887617
653	2.814913	693	2.840733	733	2.865104	773	2.888179
654	2.815578	694	2.841359	734	2.865696	774	2.888741
655	2.816241	695	2.841985	735	2.866287	775	2.889302
656	2.816904	696	2.842609	736	2.866878	776	2.889862
657	2.817565	697	2.843233	737	2.867467	777	2.890421
658	2.818226	698	2.843855	738	2.868056	778	2.890979
659	2.818885	699	2.844477	739	2.868643	779	2.891537
660	2.819543	700	2.845098	740	2.869232	780	2.892095
661	2.820201	701	2.845718	741	2.869818	781	2.892651
662	2.820858	702	2.846337	742	2.870404	782	2.893207
663	2.821514	703	2.846955	743	2.870989	783	2.893762
664	2.822168	704	2.847573	744	2.871573	784	2.894316
665	2.822822	705	2.848189	745	2.872156	785	2.894869
666	2.823474	706	2.848805	746	2.872739	786	2.895423
667	2.824126	707	2.849419	747	2.873321	787	2.895975
668	2.824776	708	2.850033	748	2.873902	788	2.896526
669	2.825426	709	2.850646	749	2.874482	789	2.897077
670	2.826075	710	2.851258	750	2.875061	790	2.897627
671	2.826723	711	2.851869	751	2.875639	791	2.898176
672	2.827369	712	2.852479	752	2.876218	792	2.898725
673	2.828015	713	2.853089	753	2.876795	793	2.899273
674	2.828659	714	2.853698	754	2.877371	794	2.899821
675	2.829304	715	2.854306	755	2.877947	795	2.900367
676	2.829947	716	2.854913	756	2.878522	796	2.900913
677	2.830589	717	2.855519	757	2.879096	797	2.901458
678	2.831229	718	2.856124	758	2.879669	798	2.902003
679	2.831869	719	2.856729	759	2.880242	799	2.902547
680	2.832509	720	2.857332	760	2.880814	800	2.903089

N.	Log.	N.	Log.	N.	Log.	N.	Log.
801	2.903633	841	2.924796	881	2.944976	921	2.964259
802	2.904174	842	2.925312	882	2.945468	922	2.964731
803	2.904716	843	2.925828	883	2.945961	923	2.965202
804	2.905256	844	2.926342	884	2.946452	924	2.965672
805	2.905796	845	2.926857	885	2.946943	925	2.966142
806	2.906335	846	2.927370	886	2.947434	926	2.966611
807	2.906874	847	2.927883	887	2.947924	927	2.967079
808	2.907411	848	2.928396	888	2.948413	928	2.967548
809	2.907949	849	2.928908	889	2.948902	929	2.968016
810	2.908485	850	2.929419	890	2.949390	930	2.968483
811	2.909021	851	2.929929	891	2.949878	931	2.968949
812	2.909556	852	2.930439	892	2.950365	932	2.969416
813	2.910091	853	2.930949	893	2.950851	933	2.969882
814	2.910624	854	2.931458	894	2.951338	934	2.970347
815	2.911158	855	2.931966	895	2.951823	935	2.970812
816	2.911690	856	2.932474	896	2.952308	936	2.971276
817	2.912222	857	2.932981	897	2.952792	937	2.971739
818	2.912753	858	2.933487	898	2.953276	938	2.972203
819	2.913284	859	2.933993	899	2.953759	939	2.972666
820	2.913814	860	2.934498	900	2.954243	940	2.973128
821	2.914343	861	2.935003	901	2.954725	941	2.973589
822	2.914872	862	2.935507	902	2.955207	942	2.974050
823	2.915399	863	2.936011	903	2.955688	943	2.974512
824	2.915927	864	2.936514	904	2.956168	944	2.974972
825	2.916454	865	2.937016	905	2.956649	945	2.975432
826	2.916980	866	2.937518	906	2.957128	946	2.975891
827	2.917506	867	2.938019	907	2.957607	947	2.976349
828	2.918030	868	2.938519	908	2.958086	948	2.976808
829	2.918555	869	2.939019	909	2.958564	949	2.977266
830	2.919078	870	2.939519	910	2.959041	950	2.977724
831	2.919601	871	2.940018	911	2.959518	951	2.978181
832	2.920123	872	2.940516	912	2.959995	952	2.978637
833	2.920645	873	2.941014	913	2.960471	953	2.979093
834	2.921166	874	2.941511	914	2.960946	954	2.979548
835	2.921686	875	2.942008	915	2.961421	955	2.980003
836	2.922206	876	2.942504	916	2.961895	956	2.980458
837	2.922725	877	2.942999	917	2.962369	957	2.980912
838	2.923244	878	2.943495	918	2.962842	958	2.981366
839	2.923762	879	2.943989	919	2.963315	959	2.981819
840	2.924279	880	2.944483	920	2.963788	960	2.982271

N.	Log.	N.	Log.	N.	Log.	N.	Log.
961	2.982723	971	2.987219	981	2.991669	991	2.996074
962	2.983175	972	2.987666	982	2.992111	992	2.996512
963	2.983626	973	2.988113	983	2.992554	993	2.996949
964	2.984077	974	2.988559	984	2.992995	994	2.997386
965	2.984527	975	2.989005	985	2.993436	995	2.997823
966	2.984977	976	2.989449	986	2.993877	996	2.998259
967	2.985426	977	2.989895	987	2.994317	997	2.998695
968	2.985875	978	2.990339	988	2.994756	998	2.999133
969	2.986324	979	2.990783	989	2.995196	999	2.999565
970	2.986772	980	2.991226	990	2.995635	1000	3.000000

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